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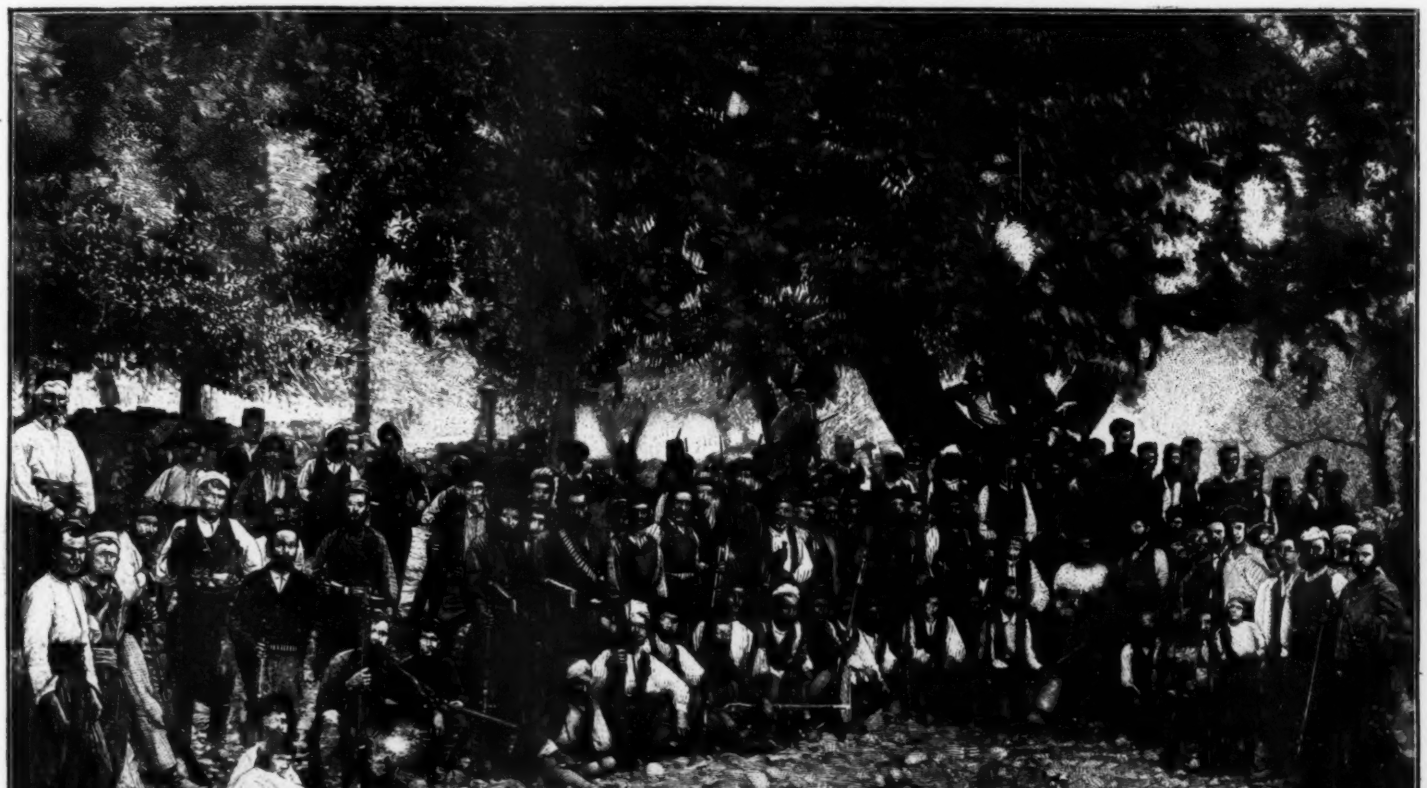
a. Administration Palace, burned February 24. b. Barracks for gendarmes in which the revolt occurred on March 3. c Greek school, occupied by German troops. d. Turkish school, occupied by Austrian troops.

THE HARBOR OF CANEA.

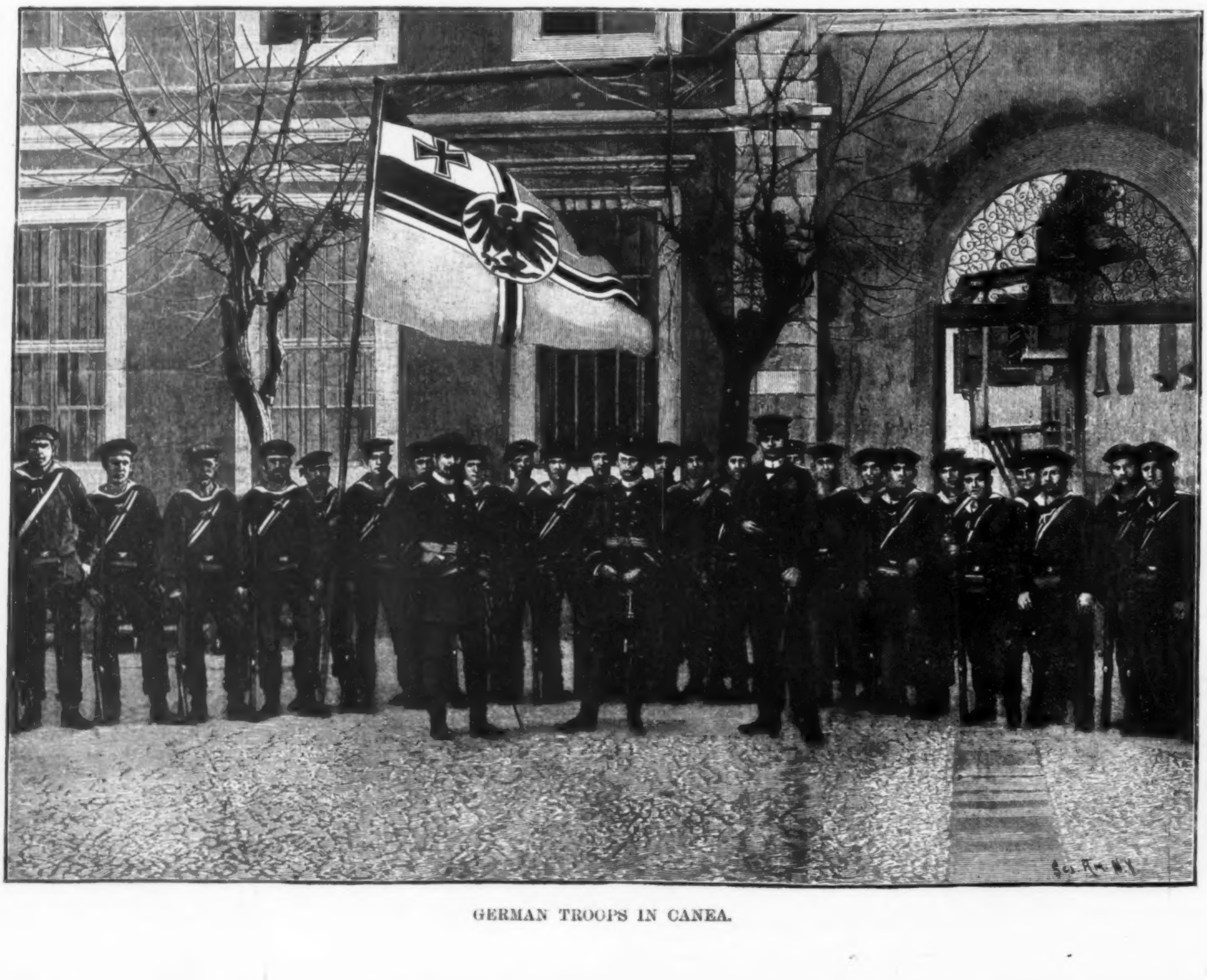


A GROUP OF GRECIAN TROOPS.

THE GRECO-TURKISH WAR.

THE actual commencement of a real war between Greece and Turkey, about the middle of April, has excited intense interest throughout the world, not so much from the possibilities of a contest between Greece and Turkey alone, as from the fact that such a war is, in itself, to all the rest of Europe, like the carrying of a blazing torch into an immense magazine of the most dangerous explosives. Since the days of Peter the Great, Russia has looked with longing eyes to obtaining an outlet, through the Bosphorus and the Dardanelles, to southeastern Russia, and all her diplomacy has tended to that end, upon which she has expended many millions of rubles, and for which she has sacrificed the lives of hundreds of thousands of soldiers. Napoleon, in the height of his power, held out the promise of his assistance to her in this object, but meant to obtain the real advantages of the possession of Constantinople for France, which has always heretofore been watchful and jealous of the advance of the great northern power to a position of strength on the Mediterranean; to Austria-Hungary, with the mixed populations and diverse religions held together with such difficulty under the Hapsburg rule, it has been of the last importance, and almost a necessity of self-preservation, that she should obtain some of the provinces bordering her present Turkish boundary, and see at least a friendly power in possession of the mouths of the Danube and the outlet from the Black Sea; germany, with her natural outlets on the Baltic and the North Sea, and with an army which is undoubtedly the most powerful and perfect fighting machine in the world, although having but an indifferent navy, has not so direct an interest in the Turkish question, except to make use of it to bind strongly to her own interests both Russia and Austria, and in the present complex situation her young emperor seems to have come forward to endeavor to control the policy of the powers with an assumption which would have done credit to the first Napoleon; Italy, from her geographical position perhaps the most interested of all the nations of Europe in the settlement of the affairs of Turkey, and the inevitable disposition of her territories, has had probably the least influence of all of them in determining the policy to be pursued, on account of the almost bankrupt condition of her treasury and the slender resources she has upon which to make any warlike demonstration; Great Britain, meeting Russia as she does on the eastern coast of Asia, in China, and along the northern boundaries of India, and to whom the protection of the Suez Canal and the maintenance of her hold on Egypt are not only matters of profound policy, but afford the only course justified by intense

DEMONSTRATION OF THE INTERNATIONAL FLEET IN SUDA BAY.

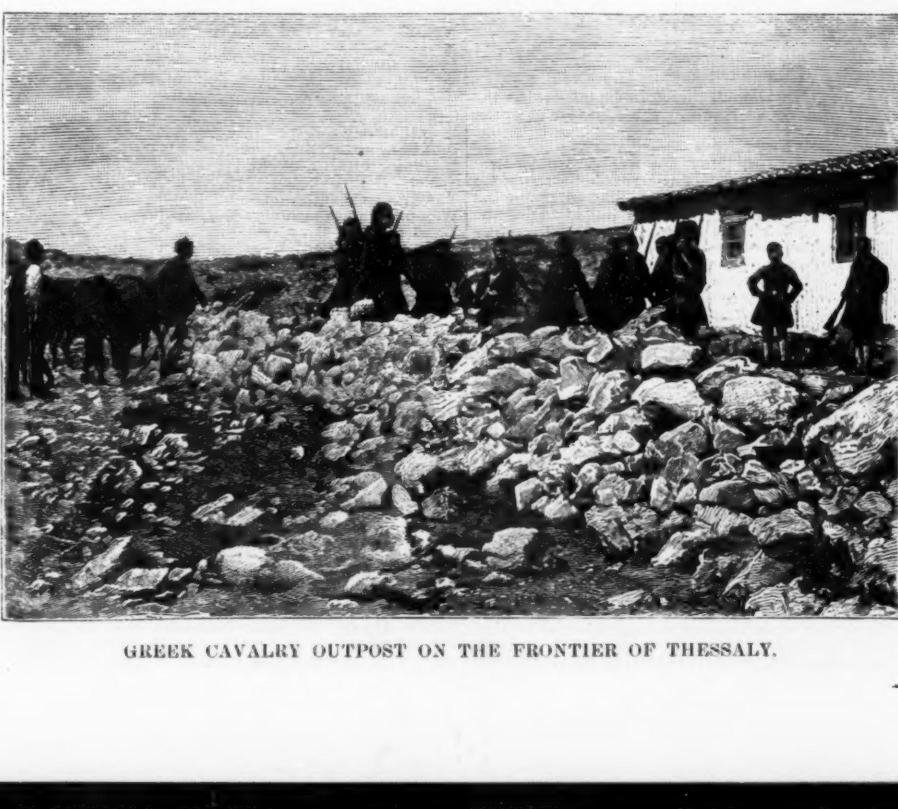


GERMAN TROOPS IN CANEA.

national conviction, is last and greatest of all to be dealt with, for she alone, at the present day, has the sea power and the financial strength to make her decision respected, and to prevent the execution of any policy of which she does not approve. To all these details of the situation should also be added the fact that the Sultan of Turkey, as head of the Mohammedan religion, can exert a powerful influence upon the nearly two hundred millions of Mohammedans in the world, and therefore is, from that fact, a power to be reckoned with beyond the immediate confines of Turkey in Europe. It is because the situation is so complex that the war in Greece, introduced by an insurrection in Crete, is of such profound interest to the rest of the world. The populations of England, France and Italy generally sympathize with Greece and hold the Turk in detestation. They would not, therefore, permit the governments of these countries to take overt measures to coerce Greece, and thus prevent the actual outbreak of war, in which the semi-independent Turkish provinces north of the Balkans have also manifested a disposition to engage to their own advantage, but the concert of the six great powers has thus far been effective to confining the war to a very limited area. The best evidence that it will not be allowed to extend itself lies in the fact that no serious disturbance has taken place in the money and produce markets of the world, which would instantly be wildly excited were a great war deemed at all probable.

THE MOSQUE AT LARISSA.

TURKISH OUTPOST ON THE MILOUNA PASS.



GREEK CAVALRY OUTPOST ON THE FRONTIER OF THESSALY.

Crete or Candia, where the real commencement of the war occurred, is an island lying southeast of Greece, about 160 miles long, nowhere more than thirty-five miles wide, and has a population of about 320,000, of whom about 70,000 are Mohammedans. Of the latter, however, very few are Turks, the Mohammedans being almost entirely native Cretans, and the Greek language being everywhere spoken throughout the island. Since 1669 the island has been subject to Ottoman rule, but in 1821, contemporaneous with the commencement of the Greek revolution, the Cretans made themselves masters of most of the island, and waged successful war against the Turks, until, in 1830, the allied powers—France, England, and Russia—intervened and transferred the island to the Viceroy of Egypt. In 1840 Crete was again transferred to the dominion of the Turks, and from that time to the present there have been many revolts against Turkish rule, it having been frequently asserted that Crete was the worst governed province of the Turkish empire. There were two considerable revolts in 1859 and 1866, followed by concessions of additional privileges to the Christian inhabitants, and a kind of constitutional government, but the strong desire of the Cretans for freedom and union with the Greek monarchy has kept the island almost constantly in a disturbed state. As members of the ruling race, the Mussulmans have enjoyed more privileges than the Christians, and they have been more generally of the governing and military class, against which the Christians have always contended.

The present troubles commenced early in February of this year, the dispatches of February 5 bringing news that desperate fighting had occurred between the Christians and Mohammedans, and that the latter had set fire to the city of Canea. It was said that many Christians who had locked themselves in their houses were driven out by the flames, only to meet death at the hands of the Turkish soldiers, who shot them down on sight, and that a number of Christians had found refuge on the warships in the harbor. The situation was so critical that marines were landed from the British and French warships to protect the French and British consulates. This was followed by the dispatch of British and French warships to Canea, and a pretty general uprising of the Christian population throughout the island, with many minor disturbances in various parts. Many thousand Cretans left the island for Greece, and the latter country began at once to take measures to support the Cretans in their efforts for independence or annexation with Greece. Greek warships were sent to the island, and Greek soldiers, under the command of Col. Vassos, and the greater part of the island except the towns and cities soon became largely under the control of the insurgents. At this point the leading powers of Europe—Great Britain, France, Russia, Germany, Austria, and Italy—reached a sort of agreement to interfere unitedly in favor of maintaining the government of Crete as it had been under the Turkish dominion, and prevent its annexation to Greece, and a blockade of the island was therefore ordered, in which vessels of all the great powers participated.

One of our illustrations represents a great squadron of war vessels, in which all the great powers were represented, assembled in Suda Bay, a large and safe harbor on the north side of the island not far from Canea, which is at the western end of the island. Canea is now the capital of the island and one of its principal cities. One of our views shows its harbor and represents also some of the buildings of more especial interest. The governor's palace, which was burned, was of wood. The energetic efforts of the British marines, who form a part of the foreign force occupying the town, alone saved the thickly populated district in which the palace is situated from destruction. Detachments of sailors from the warships in the harbor were landed, and rendered valuable aid in fighting the flames. The fire destroyed the last vestige of the machinery of the Turkish government. All of the records were consumed, as well as contracts and financial, legal, and municipal documents. While the palace was burning, the Moslem rabble set fire to several houses in the town and suburbs. The Montenegrin police who patroled the town extinguished these fires when it was possible for them to do so, but three large houses belonging to Christian merchants who were absent were destroyed. All of the foreign warships have landed detachments, and one of our views represents a group of German soldiers thus detailed, another view showing a group of insurgents. Although the island has thus been surrounded by the warships of the European powers, and small bodies of troops have been landed at a few points, there has been comparatively little serious fighting there, the insurgents generally holding the interior, determined to hold out for annexation to Greece.

Words can but poorly describe the intense excitement which has prevailed throughout Greece during every phase of the trouble in Crete, the inhabitants of Greece, almost as one man, joining in the demand for war against Turkey, in the hope of thereby not only insuring the success of the Cretans, but possibly of attaining a further annexation of Greek territory now tributary to Turkey in Macedonia and Epirus. But Greece, with her two million population, is a small power as compared with Turkey, with thirty-five millions. The war between Greece and Turkey practically commenced on the 14th of April, with battling all along the northern frontier of Greece, where the Turks had assembled an army of veterans, well drilled by German officers. The Turkish army is said to have numbered 135,000, against whom the Greeks could only bring

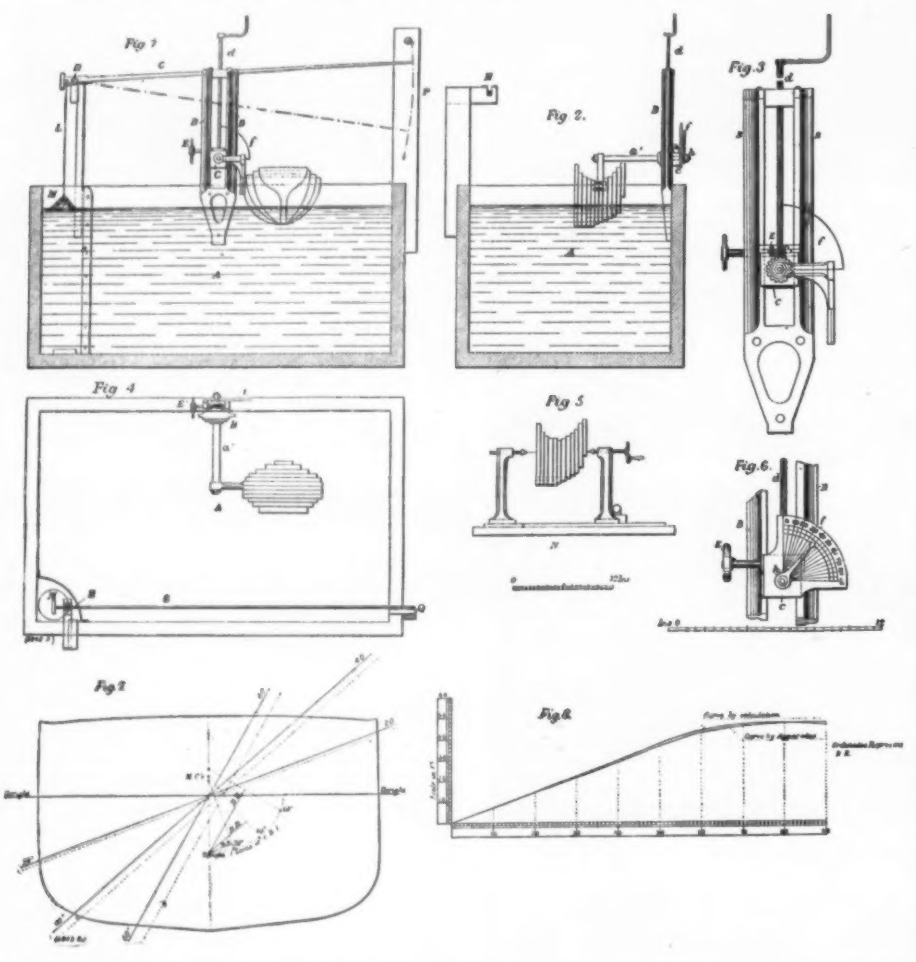
about 80,000 irregular troops. The Turks forced their way through the somewhat difficult mountain passes which are on the frontier line, and have taken possession of the city of Larissa, from which the Greeks retreated; but to effect this it required a week of almost continuous fighting, the resistance of the Greeks having been extremely obstinate and the fighting of the fiercest and most determined description. Some of the hardest fighting occurred at Milouna Pass, a small fort near which is shown in one of our views, another view representing a Greek outpost, while a further picture is a view taken at Larissa. Although the Turks have, however, thus fought their way a short distance into northern Greece, the Greeks have made some advances into Turkish territory in Epirus on the west coast, and the Greek fleet has destroyed some Turkish stores and endangered the Turkish lines of communication on the east coast. The many fears entertained that the conflict would grow into a great war have been held in check by the concert of the powers, who have thus far acted with substantial unity for the preservation of peace and the confining of the war to the narrowest possible limits. For the engravings we are indebted to Ueber Land und Meer and Le Monde Illustré.

ASCERTAINING THE STABILITY OF SHIPS.

A MECHANICAL METHOD OF ASCERTAINING THE STATICAL STABILITY OF SHIPS.*

By Mr. A. G. Ramage, Member.

The apparatus consists of a small tank, A, holding water. The surface of the tank should be just sufficient to admit the wood sections of the ship, and permit them to be turned through the required angles.



B, Figs. 1, 2, 3, 4 and 6, is a frame attached to the sides of the tank, guiding the sliding block, C, which can be raised or lowered by the screw, d; a′ (Figs. 2 and 4) is the arm to the outer part of which the sections are attached; a′ can be turned through any angle by the worm, E (Figs. 3 and 6), the angle being indicated by the finger, h, on the plate, f (Fig. 6); G (Figs. 1 and 4) is the indicating arm balanced on a knife edge, H, and multiplying at its free point the vertical motion imparted to it by the float, M, through the rod, L.

Sections of wood representing mean sections, over the length each represents in its thickness, are attached to the arm, a′, so that they are vertical when the finger points to zero, and so that the water line to which the sections are to be immersed is parallel to the surface of the water. The sections are then screwed down into the water by the screw, d, till they are immersed to the required line. The float having risen owing to the displacement of the water, the indicating hand has moved through a large angle, P.

When the water is still, mark the position of the indicating hand on the board placed behind it, then raise the sections, and by the worm turn them round to the first angle of heel, say 20 degrees, screw them down till the indicating hand has swept through the same angle as for the upright displacement. They are then at the correct draught for the inclined position. Make a pencil mark on one or two points of the sections at the surface of the water, then lift the sections by the vertical motion.

The sides of the tank having been made level to the surface of the water, lay a straight edge across the sides of the tank, and draw the water line all round.

When the inclined water line has been drawn, unscrew the sections and saw off the immersed part, balance it on the needle points, and ascertain its center of gravity or center of buoyancy, and measure with a scale its position from the center line and from water line. Glue the sections together again, putting in a layer of wood to make the saw rift, and repeat the operation for other angles.

The points thus obtained having been set off on the body plan, with the center of buoyancy calculated for the upright position, gives us the locus of centers of buoyancy, from which the righting arms may be measured.

I shall now deal with some of the objections which might be raised to the system, and also point out some of the difficulties which have to be overcome and things to be guarded against. I do not think any one will object to the balancing of sections, because other systems which have gained considerable credit make use of these, and, though the homogeneity of the wood used is an essential, this can generally be secured by selecting clean yellow pine for the purpose. The sections should be balanced first on the center line to prove that both sides are of equal weight. The water absorbing powers of both sides should also be the same, or else the balancing should be delayed until the wood is dry. Yellow pine absorbs an amount of water, even after being coated with varnish, sufficient to sensibly affect the indicator hand. That is to say, the point of rest of the indicator will be higher after the sections have been lowered and raised than before the sections were put in. Care should, therefore, be taken that the indicating arm passes through the same arc as in the first instance.

The chief point we have to consider is the sensitiveness of the indicator. May not a layer sufficiently large to affect the accuracy of the result be too small to affect the indicator? Here is a sheet of tin, of the size of the cross section at the water line at 30 degrees inclination, which, on the scale to which the sections are made, represents about ⅜ inch. If that sensibly affects the indicator, we may conclude that it is sensitive enough for all practical purposes. I put it in the water, and there is a sensible motion of the indicator.

The difficulty of marking the sections correctly, owing to the viscosity of the fluid, is an objection that might be raised, but if some blue be mixed with the water there is not much difficulty in marking the true position of the water line.

The time necessary to make the sections and perform the operation is not great if we leave out the time which the glue takes to harden when the parts are being reunited. A smart model maker will cut out the sections in about four hours, dipping, sawing and balancing two hours and gluing up say two hours.

The advantage lies in this, that the intelligent joiner or model maker can perform the whole operation, and he who is responsible can satisfy himself by a glance of the accuracy of the results, without wading through a labyrinth of figures. Pins can be driven into the sections to mark the position of the centers of buoyancy, the mean position of which should be set off on the midship section drawing.

The indicator on my apparatus magnifies the vertical motion of the surface 40 times. As to results, you will find on diagram, Fig. 8, curves showing the comparison of the result of calculation with the results given by the apparatus. The time necessary to get a sufficient number of points, say at 20 degrees, 40 degrees, 60 degrees and 90 degrees, is probably the worst feature of the arrangement; but if three or four vessels are worked at the same time, which can be done, the time taken is much less than for the ordinary calculation. It is very important that the center of buoyancy for the upright position be very carefully calculated.

* Paper read before the Institution of Naval Architects and republished from London Engineering.

COMPARISON OF THE STABILITY OF THE ALABAMA AND THE PRINCE GEORGE.

In view of the trouble and disaster which the English designers experienced with their earlier battleships, as the result of their lack of stability, the following paper which appeared in a recent issue of The Engineer is of special interest. The Captain, an early turret ship, capsized in the Bay of Biscay with practically the loss of a whole ship's company, and in very recent years the Resolution, a 14,000 ton ship, rolled so badly in the same stormy bay that her officers put back to Plymouth. The rolling was remedied by fitting bilge keels to this ship and her class. Since then the Prince George class has been built, and it is reasonable to suppose that in this vessel stability has been made a first consideration.

It should in all fairness be mentioned that the cross section of the Alabama, showing the height at which her heavy guns and turrets are carried, is somewhat misleading, as it would lead the reader to suppose that both turrets were carried at the same height. As a matter of fact, the after turret is seven feet lower than the forward one, and her freeboard is proportionately reduced over one-third of her length. This will result in a reduction of top weight which will go far to offset the admittedly great weight of her 13 inch guns and turrets.

The criticism of The Engineer is as follows: It is impossible to make a comparison between the dimensions and other features of the three new sea-going United States battleships and those of our own Magnificent type, without wondering whether one of the two constructive departments has not erred in judgment, so widely do their conceptions differ from one another, or whether this vast divergence of conception is the result of difference in conditions as obtaining in the United States of America and in the British Empire respectively.

In the first place, what is a "sea-going battleship"? We should like to have this point explicitly settled, before venturing to express any opinion upon the proposed Alabama class. Is it a mere floating fort, intended to be maneuvered from one sheltered position to another, in calm weather; or is it a fighting factor of the line of battle upon the high seas? We take it that the Briton and the Yankee will unhesitatingly agree that the second definition is a correct one. It is true that the American notion of a base of naval operations and that of a British admiral are by no means identical. The very wording of the first United States naval programme showed that "coast defense" was the object aimed at, the raison d'etre of the American fleet. The introduction of swift and powerful cruisers was merely an expedient for "commerce destroying." Moreover, that question is beyond the limits of the present subject; we are dealing exclusively with battleships. On the other hand, the base of operations of a British fleet is, admittedly, the enemy's seaboard, so that our field of battle may be anywhere upon the high seas. But either of these separate views, as to the scope and nature of the duties of a fleet, demands that the component factors of it should be capable of holding their own in a seaway, independently of weather.

Hence, so far as one can see, the only important condition as to the requirements of the British battleship which differs from that demanded in the United States is in the amount of coal which it is deemed advisable to carry. The bunker capacity of the Prince George, for instance, is 2,250 tons, while that of the three American vessels is only 1,200 tons each.

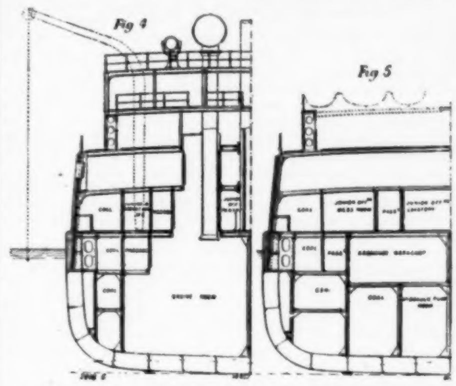
But this trifling variety in conditions bears no proportion whatsoever to the extraordinary dissimilarity found to exist between the features which mark the respective types of battleship now under consideration. Some of these may be seen at a glance over the figures of the following tabular statement, and over the comparative tables of the ships of various powers:

	Prince George.	Alabama.
Length on load water line	390 ft.	368 ft.
Beam extreme	75 ft.	72 ft. 2·5 in.
Freeboard, forward	25 ft. 3 in.	19 ft. 6 in.
" aft	20 ft. 0 in.	13 ft. 6 in.
Displacement, at the maximum draught	14,900 tons.	12,000 tons.
Coal bunker capacity	2,250 tons.	1,200 tons.
Indicated horse power	12,000	10,000
Maximum mean draught	27 ft. 6 in.	24 ft. 9 in.
Speed	18 knots.	16 knots.
Thickness of belt armor	9 in.	16½ in.
Weight of main armament	184 tons.	240 tons.
Total weight of revolving turrets or hoods, with turntables, guns and projectiles in ready racks	620 tons.	940 tons.

On running through these tables, we observe that upon a displacement of 3,000 tons less than that of the Prince George, with length and beam considerably reduced, draught lessened to the seemingly dangerous extent of nearly 3 ft., giving a coefficient of bluffness equal only to 0·6 of the solid rectangle, or practically a form beneath the water line assimilating to that of the swiftest "greyhounds" of the Atlantic, and a depth of freeboard 5 ft. less than that of the British war vessel, the United States naval constructor has piled up an armament of four heavy guns, weighing 56 tons more than the corresponding main armament of the Prince George, the forward pair of which is practically at the same height above the water line as our own guns, while the pair aft is a trifle lower, to say nothing of an additional pair of 6 in. quick-firers. He has further added to the superincumbent top weight huge revolving turrets of 15 in. and 18 in. steel armor, making the total of turning parts no less than 940 tons, instead of 620, as in the Prince George. It seems incredible that stability has not suffered by such treatment. Probably it will be urged that the extra proportion of beam to length—

the Alabama being as 1 to 5, while the Prince George is only 1 to 5½—may inspire confidence, as affording a certain amount of extra metacentric height. This is true; but, whatever may be said to the contrary, nominal metacentric height is of uncertain value to a seagoing ship when the center of gravity is dangerously raised; and this cannot fail to be the case with regard to the Alabama, if she is actually to carry all the armor, guns, and heavy top weight accredited to her.

We invite inspection of the accompanying diagrams, which illustrate our argument, and which show midship, or rather compound sectional views of the Alabama and of the Prince George, each rolling to an angle of 30 deg., that being the extreme angle to which our naval clinometers are graduated, and, evidently, an angle of heel which may be anticipated in a gale of wind with a heavy sea on. It is seen that the Alabama lies so far over that her main deck aft, which has nothing over it beyond the superstructure end, is flooded with green seas almost up to the barbette wall. This is shown in the drawing in dotted lines. Moreover, nearly the whole length of the upper deck has its edge under water, for the small armored two 6 in. quick-fire gun casemates on that deck, marked in dotted lines, give practically no increment at all to the vessel's freeboard, and as the Alabama has no sheer forward, the edge would be under water to the very stem. On the other hand, the Prince George at the same angle of heel would not have green seas over any portion of her upper deck's edge, as for a considerable length of her side the upper deck battery intervenes, and forward there is a sheer of 6 ft., rising gradually to the stem, while aft the slight sheer given is sufficient to turn aside

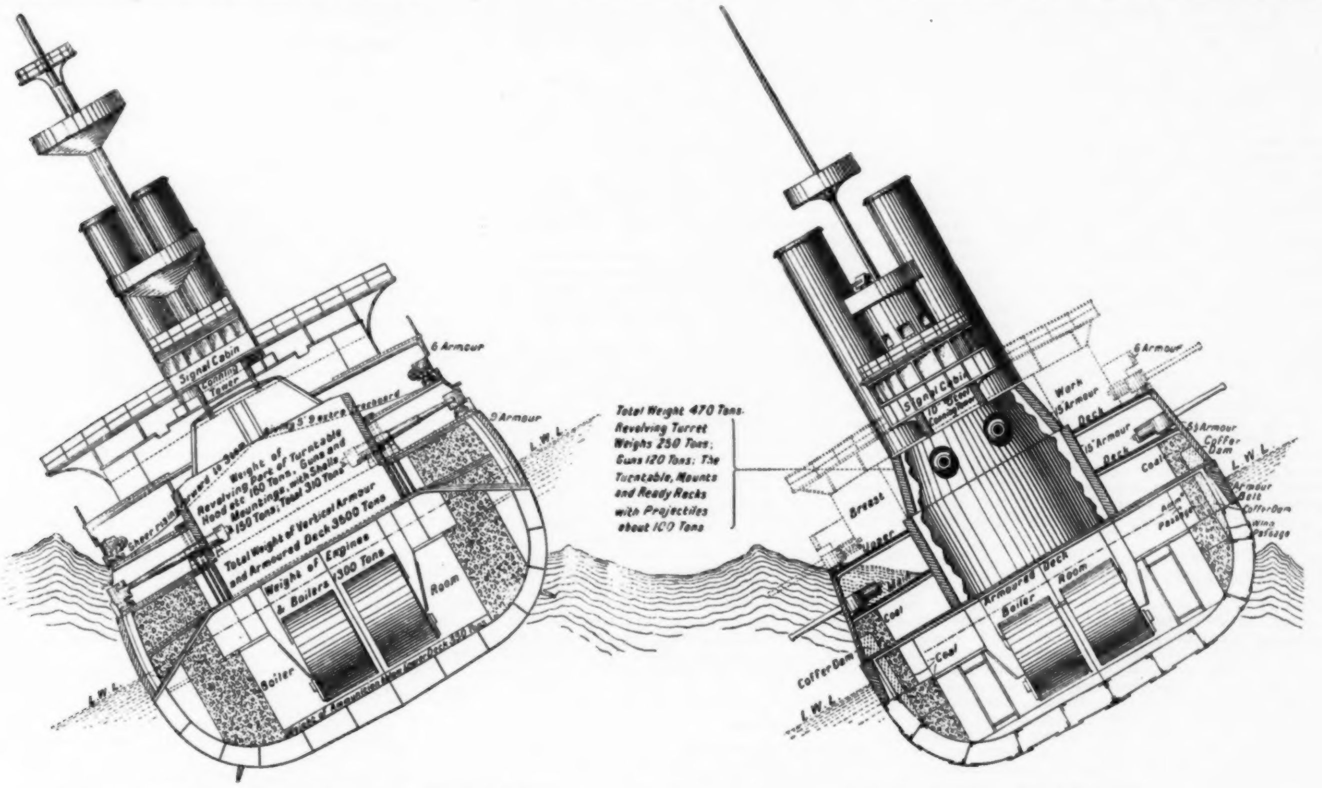


HALF CROSS SECTIONS OF THE BATTLESHIP ALABAMA.

an approaching wave. In point of fact, she might lie over several degrees more, without enduring greater inconvenience than a sprinkling over the upper deck aft.

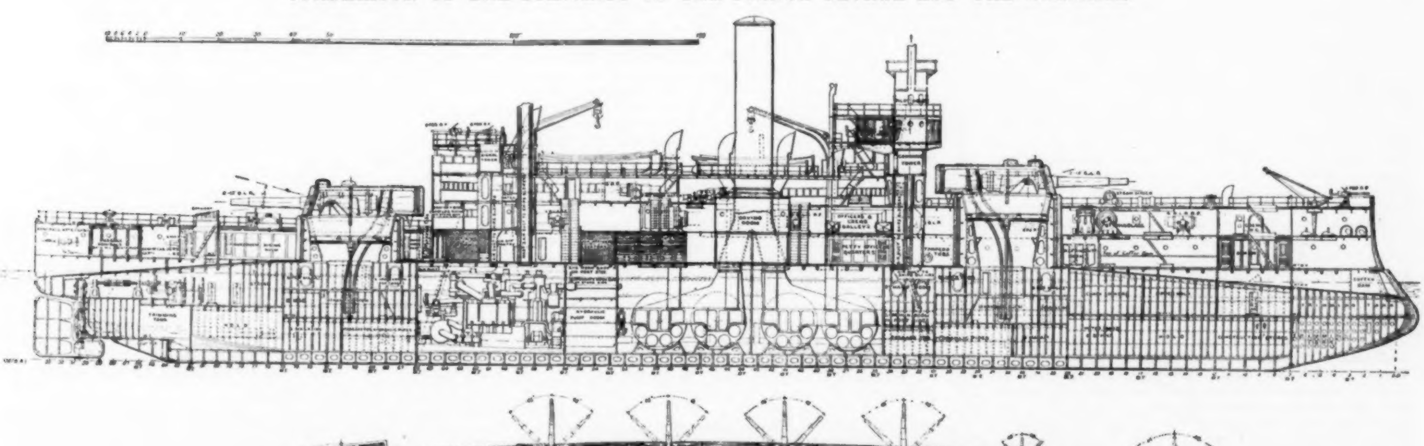
But the extra weight of so many tons of water upon the deck's side of a vessel, weighted as will be the Alabama, and lying over to a considerable angle of heel, is a very serious matter to contemplate. A considerable part of the barbette walls—probably the whole, indeed—of 15 in. steel and the revolving portions weighing with their guns 470 tons each, all the secondary armament and its mountings, the 5½ in. armor upon the ship's sides, the coal in the upper bunkers, the conning towers, the huge forward fighting tower, and other impediments, are all presumably above the center of gravity, if we estimate that to be about at the level of the armored deck, which is probably the case; although the weight of the side belt armor 16½ in. thick, the engines and boilers, the magazines and ship's stores, may be sufficient, with the coal in the lower bunkers, to keep the vessel stable when upon an even keel. It is only necessary to look at the drawing, therefore, to see what a terrible position a large proportion of these top weights assume when the ship heels over, and their dangerous tendency is further enhanced by the weight of superincumbent water upon her deck. The vanishing point of the curve of stability, it would appear, must be arrived at with a very moderate angle of heel.

It is quite a relief to turn our attention to the Prince George's cross section. Here we find a large part of the armored deck—an item of immense importance as



Section of Prince George rolling to Angle of 30° *U.S. Battle-ship to Angle of 30°.*

COMPARISON OF THE STABILITY OF THE PRINCE GEORGE AND THE ALABAMA.



THE UNITED STATES BATTLESHIP ALABAMA.

Length, 368 ft. on water line; beam, 72 ft.; mean draught, 24 ft. 7 in.; displacement, 11,520 tons; speed, 16 knots. Main battery: Four 13 inch guns; fourteen 6 inch rapid fire guns. Secondary battery: Seventeen 6 pounders; six 1 pounders; four Gatlings; one field gun.

affecting the ship's stability, for it weighs 1,300 tons—brought down at the sides so as to lie beneath the center of gravity, and also so as to form a pyramidal figure, the very best disposition, as stevedores tell us, for the purpose of stable lading. The engines, boilers and ammunition, computing to a total of 1,630 tons, rest, of course, upon the lowest flat of all, so that every pound of this weight adds steadiness to the vessel's position, whether on an even keel or lying over, while much of the extra coal carried, being also placed below the center of gravity, has the same tendency. Then the huge revolving turrets of the Alabama, the steel armor of which alone weighs 500 tons, are represented by light hoods 6 in. thick at the sides, which are ample in resisting power for the requirements of the situation. For in this connection it is quite clear that if a couple of rounds from a heavy 12 in. or 13 in. gun get fairly on to a ship's turret at short range, they will put it out of action, even if the walls are strong enough to resist penetration; whereas part of the hood over the 12 in. barbette guns of the Prince George might be knocked away without putting the guns out of action at all. Again, with the experience of the Victoria fresh in our memories, we can never desire to revert to heavy revolving turrets, which must ever be an element of instability that no desirable arrangement of weights can counteract.

It is a matter of congratulation to this country that our naval constructors have at their head a man of such original character and exceptional ability as Sir William White. The gradual development of ideas in the war vessels which he has designed is very remarkable. As we pass from the Trafalgar to the Royal Sovereign, and from the Royal Sovereign to the Prince George, we find immense changes, but one leading thought throughout—the conversion of a mere floating fort into a sea-going battleship.

With this end always in view, freeboard was improved, the heavy gun positions were separated, so as to create space for secondary batteries of exceptional power, the double bottom system was developed so as to embrace practically the whole of the hull beneath the armored deck, and coal capacity was increased fourfold. What can be more workmanlike and shipshape than the arrangement of barbettes, casemates, coalbunkers, and armor that we find upon the cross section given of the Prince George? Compare it with the structures of the modern French and other foreign battleships now in the Mediterranean. We seriously doubt whether a half a dozen of them would outlive an Atlantic gale.

When we find irresponsible persons in this country drawing comparisons between the war vessels designed in the United States and those which have emanated from the constructive department of our own Admiralty, to the disadvantage of the latter, we feel bound to speak out. The cross sections which we give above, however, speak more plainly for themselves than any words which we can write. We commend them to the notice of a critical public. They represent with quite sufficient accuracy all the facts of construction. The American designer apparently holds that his ship will never roll to 30 deg. He does not know the Atlantic.

BENARES THE ANCIENT.

FIVE and twenty centuries ago, when Rome was not yet on the records of the world, and when Athens was in its infant splendor, Benares, on the noble Ganges, exerted a mighty power and her fame was established among men. Here, says the Baltimore Sun, the great Buddha proclaimed his doctrines first, sending forth missionaries from this center to Ceylon, China, Japan, Burma and Thibet, bringing in time nearly half the race of man under the influence of his teachings. But centuries afterward, during a powerful religious and political upheaval, Buddhism succumbed to Brahmanism, leaving behind only the ruins of its tombs and temples. And to-day, what Mecca is to the Mohammedan, Jerusalem to the Christian, Benares is to the Hindoo.

The city is located along the crest of a hill over one hundred feet above the sacred Ganges. For three miles on the sloping west bank, palaces, temples and mosques, surmounted by domes, pinnacles and minarets, rear their irregular tops. Giant flights of stone stairs, interrupted by wide platforms, on which are built shrines of every description, reach to the water, and on the edges of the bank are bathing ghats, which are crowded with pilgrims from every part of India and from other countries, in every stage of dress and undress, whose supreme desire is to plunge into these holy waters before death overtakes them. These pilgrims are not all from the lower or middle classes, but include every rank of Indian society, from the elaborately dressed rajahs, followed by long retinues of attendants, to the unsightly looking ashes-covered fakir and the miserable deformed beggar, and from the little boys and girls to the aged grandfathers, lifted by bearers to the stream, all bent upon dipping in the Mother Ganges for the remission of their sins.

Many of the women and girls carry wreaths of white and yellow flowers into the river, and, as they most devoutly turn their faces toward the rising sun and inaudibly whisper their prayers, the garlands are broken into pieces and scattered upon the river. Hundreds of these devotees are seen with brass jars and other vessels in which they carry away to their distant homes some of the holy water, and employes of the temples from central and southern India are there with their leather water bags, which are to be filled and borne on the backs of pedestrians for scores and scores of miles to their houses of worship.

Along the river bank there are not less than fifty of these ghats, which have for their background magnificent flights of steps leading up to imposing castles and palaces, great white mosques and soaring minarets. The Panchganga ghat, where five rivers are supposed to meet underground, leads to the noble mosque which the iconoclast Aurangzeb built on the site of the noted Krishna temple, which he destroyed.

This is the finest mosque in Benares, the foundations of which rise from the bed of the river in huge stone breastworks, which support the four walls and domes of the mosque, and springing lightly in the air are two graceful minarets, lifting the whole structure three hundred feet above the swarm of bathers at the water's edge. In sailing up the river you pass the ghat where Vishnu dug his famous well, where Brahma made his celebrated sacrifice of ten horses, the Golden Temple and many other spots that have made the city known the world over.

In the midst of these places of worship is located the Burning Ghat, where bodies are brought from all over India to be bathed in the Ganges and then cremated on its banks. Smoke from four pyres was seen as we approached the ghat, and several corpses wrapped in white cloth and lashed between two stout sticks were being washed in the sacred stream, while the relatives of the dead were preparing the wood near by for the cremation. Bedecked with flowers and sometimes wearing jewelry, the bodies are laid between layers of wood. The ashes are cast into the water, and we saw a number of men at work who make a regular business of searching the shore and filtering the water through baskets in search of jewels or money that perchance might have dropped from the dead.

One of the most curious places visited was the Durga or Monkey Temple. Durga is thought to delight in all kinds of bloodshed and destruction, and while we watched the worshipers a man approached the blood-bedabbled altar in front of the shrine and, having placed a number of coins in the hands of the officiating priest, was given the privilege of having a little kid that he held under his arm beheaded, and after the sharp blade had descended he made an offering of the head and carried the body away to his home.

In the yards and trees about the temple are hosts of monkeys, who spring into your pathway, peer around the walls, snatch at your clothes and make the most comical grimaces at you on the least provocation; but it is a crime to molest them, for they are gods and goddesses, held in the highest veneration. I could hardly suppress an irreligious laugh as I watched one of these goddesses holding a baby god under her left arm while she held a nut in her right hand, on which she was nibbling in the most human fashion, and during the whole performance she was making the most unholy faces at me because of my inferiority.

What the monkey is to Vishnu, the cow and bull are to Siva. To slaughter these animals is a horrible crime, and in every part of India can be found temples dedicated to their honor, where they are kept with the greatest care.

One of the curiosities of humanity is the "holy man of Benares." His long continued acts of penance have worn his body to skin and bones. He is thought by many to be above all passion and sin; he declines to receive anything from visitors, and his bright eyes, sweet expression and soft voice seem to indicate that he possesses a serenity in life that is enjoyed by few. His name is written Matparamahausaparinrajakacharyaswamibhaskaranaudasaraswati!

To those who enjoy examining curios and artistic manufactures, the bazars of Benares will prove to be especially attractive. The city is famous for its beautifully engraved brasswork, and trays, water vessels, bowls, lotus dishes, candlesticks, lamps, fancy boxes, bells, spoons and scores of other utensils, engraved most exquisitely, can be purchased for remarkably cheap prices. Rich brocades wrought with figures of animals in gold and variegated colors, the oldest survival of ancient loomwork extant and the finest of its kind in the world, are found in the tiny shops in the bazars; and this beautiful work is done by experts who receive about three or four dollars a week. When a piece is finished it is "worth its weight in gold," but the poor fellow whose genius created the masterpiece lives and dies in poverty, while some merchant in Europe or America gets the "weight in gold."

A SILVER PALACE FOR OMAHA.

EDWARD ROSEWATER, chief of the bureau of publicity and promotion of the Transmississippi Exposition, to be held in Omaha from June to November, 1898, acting for the exposition directors, has approved and accepted the plans of Architect S. S. Beman, of Chicago, for a silver palace, says the Chicago Times-Herald. This palace is to be the most imposing feature of the exposition, and the central figure in a portion of the grounds to be called El Dorado. As a distinctive part of the great exposition it promises to rival the Eiffel tower or the Ferris wheel. The building is to be 400 feet square, surmounted with mammoth ornamental towers, and the entire structure will be covered with rolled silver. The silver palace will be used entirely for the display of the mineral products and progress of the West. The style of architecture is purely Gothic, and as this style lends itself readily with its pinnacles, arches, flying buttresses, and graceful and delicate forms, to the ideas usually associated with silver art work, it has received the general verdict of approval of the board of management. It will be arranged in the form of a square, with open arcades and loggias at each story similar to the Venetian palace. The corners will be adorned with octagonal towers, terminating with spires and pinnacles covered with the shining metal. The crowning glory of the palace will be the central lantern or spire, which is octagonal in form, 250 feet high and 100 feet in circumference. The roof of the lantern will be of glass.

The amount of pure silver to be used in covering the walls and dome of this mammoth building has not been definitely estimated. It will largely depend upon the thinness of the sheets of pure metal that can be used for this purpose. It was first designed to coat the building with silver paint, but this was indignantly rejected by the board of managers. Only the real metal was adjudged worthy of this novel monument of artistic architecture, and the miners of the Western country have already signified their willingness to furnish all the material necessary. The contribution of silver will be in the nature of a loan, and when the exposition is over the building will be burned and the silver returned to the original owners.

Gas at one dollar per thousand cubic feet has been furnished in Boston now for two years, since the general assembly passed a law establishing its price, in obedience to public clamor, but the people are not satisfied with it. They now complain that the gas is poisonous, containing more than 30 per cent. of carbonic oxide. Forty deaths are said to have taken place from asphyxiation, and nearly as many more narrow escapes from fatal inhalation of the gas, from February 5, 1896, to January 4, 1897.

SELECTED FORMULÆ.

Dextrin Paste—Mucilage.—

(1)	Dextrin	50-90 parts.
	Alum	4 "
	Sugar	75 "
	Water	120 "
	Carbolic acid solution, 10 per ct.	60 "

Mix.

(2)	Gum arabic	4 parts.
	Water	8 "
	Glycerin	1 "
	Neutral spirit	3 "

Mix.

(3)	Gum arabic	70 parts.
	Water	200 "
	Aluminum sulphate	2 "

Dissolve the aluminum sulphate in a small portion of the water and the gum arabic in the rest, and mix the solutions.

Witch Hazel Cream.—

White petrolatum	54 parts.
Yellow wax	9 "
Spermaceti	9 "
Spirit hamamelis	14 "
Perfume	To suit.

Melt the first three ingredients together, allow to cool slightly, add the witch hazel extract, and stir; when nearly cold, add the perfume and stir vigorously.

Moth Liquid.—

Carbolic acid	1 drachm.
Camphor	1 "
Benzin	3 ounces.

Mix and dissolve. May be sprinkled or sprayed where it is required.

Sympathetic Inks.—

INKS THAT APPEAR THROUGH HEAT.

1. Write with a concentrated solution of caustic potash. The writing will appear when the paper is submitted to strong heat.

2. Write with a solution of hydrochlorate of ammonia, in the proportion of 15 parts to 100. The writing will appear when the paper is heated by holding it over a stove, or by passing a hot smoothing iron over it.

3. A weak solution of nitrate of copper gives an invisible writing, which becomes red through heat.

4. A very dilute solution of perchloride of copper gives invisible characters that become yellow through heat.

5. A slightly alcoholic solution of bromide of copper gives perfectly invisible characters which are made apparent by a gentle heat, and which disappear again through cold.

6. Write upon rose colored paper with a solution of chloride of cobalt. The invisible writing will become blue through heat and will disappear on cooling.

7. Write with a solution of sulphuric acid. The characters will appear in black through heat. This ink has the disadvantage of destroying the paper.

8. Write with lemon, onion, leek, cabbage or artichoke juice. Characters written with these juices become very visible when the paper is heated.

INKS THAT APPEAR UNDER THE INFLUENCE OF LIGHT.

9. Chloride of gold serves for forming characters that appear only as long as the paper is exposed to daylight, say for an hour at least.

10. Write with a solution made by dissolving one part of nitrate of silver in 1,000 parts of distilled water. When submitted to daylight, the writing appears of a slate color or tawny brown.

INKS APPEARING THROUGH REAGENTS.

11. If writing be done with a solution of acetate of lead in distilled water, the characters will appear in black upon passing a solution of an alkaline sulphuret over the paper.

12. Characters written with a very weak solution of chloride of gold will become dark brown upon passing a solution of perchloride of tin over them.

13. Characters written with a solution of gallic acid in water will become black through a solution of sulphate of iron, and brown through the alkalies.

14. Upon writing on paper that contains but little sizing with a very clear solution of starch, and submitting the dry characters to the vapor of iodine, or passing over them a weak solution of iodide of potassium, the writing becomes blue, and disappears under the action of a solution of hyposulphite of soda in the proportions of 1 to 1,000.

15. Characters written with a ten per cent. solution of nitrate of protoxide of mercury become black when the paper is moistened with liquid ammonia, and gray through heat.

16. Characters written with a weak solution of the soluble chloride of platinum or iridium become black when the paper is submitted to mercurial vapor. This ink may be used for marking linen. It is indelible.—Les Inventions Nouvelles.

Nux for Cut Flowers.—Dr. Dixon states that tincture of nux vomica, added to the water in which cut flowers are kept, exercises a stimulant effect upon the flowers. The chrysanthemums on which he tried it held their freshness for an unusually long time.—Bull. Phar.

Bronzing Aluminum.—The German press gives the following information concerning a curious process for bronzing aluminum, discovered by a professor of the artillery school of Berlin. Commercial aluminum contains silicon and iron; it is a mixture of pure aluminum, aluminum alloyed with silicon, and aluminum alloyed with both silicon and iron. An ammoniacal solution has been found which dissolves pure aluminum and does not act upon the above mentioned alloys, which remains as a superficial brown-tinted coating. The coating of alloy is porous, which is disadvantageous, but the inventor has triumphed over this, and makes the coating completely continuous and impervious by heating the aluminum to a moderate temperature and then treating it in a particular manner not mentioned. It is said that the aluminum thus protected is unattacked by salt water, and may be used without fear for boats or torpedoes.—From L'Electrochimie.

ENGINEERING NOTES.

Four systems of tramway traction are employed in the Netherlands, viz., steam, mixed (steam and horses), horses only and electricity. According to the return for 1894 the mileages of these were as follows: Steam only, 293·9 miles; mixed (steam and horses), 228 miles; horses only, 124·9 miles; electricity, 3·1 miles.

In 1865 England's share in the production of pig iron was 64 per cent. of the aggregate production of the United States, France, Germany and England, France contributing 14 per cent., the United States 12 per cent., and Germany 10 per cent. In 1895 the United States supplied 38 per cent., England 31 per cent., Germany 23 per cent., and France 8 per cent. In 1850 England produced 57 per cent. of the total output of pig iron in Europe.—Stahl und Eisen.

The first blast furnace in which coke was used as fuel was operated in 1619 by Dud Dudley, of Pensant, Worcestershire, England. He obtained a patent relating to the manufacture of coke for a term of 31 years, but, owing to the opposition of the smelters, the term was shortened to 14 years, and Dudley's furnace was destroyed by workmen hired for that purpose. The invention was then forgotten, and was revived in 1735 by Abraham Darby, who operated a blast furnace with coke at Colebrookdale, Shropshire.—Stahl und Eisen.

The letting of two large contracts for cast iron water pipe at about $15.25 per ton, says the Engineering Record, should be noted by those who are liable to have to purchase pipe at any time in the near future. Pipe prices are too low to last long, and it would seem only common prudence for towns whose credit is good to take advantage of the cheapness of water pipe and the rate at which money can be had for safe investments and either build water works or make any extensions to already existing plants that are likely to be needed for some years to come.

It would seem from reports at hand that aluminum sheets afford an effective means for roofing buildings. Some time back the roof of the Berlin Industrial Exhibition was covered with sheets of aluminum 6 mm. thick, and laid with polished surfaces outside. The result, it appears, has been very satisfactory, for the roof has withstood all climatic influences, weather, and changes of temperature, without showing signs of oxidation. So excellent, indeed, are the results, that experts express the opinion that aluminum will become a strong competitor with other materials for this kind of work in the future.

A cold blast was first used in blast furnaces, the first practical blast apparatus being introduced by Smeaton, at the Carron (Scotland) iron smelting works. A great improvement was made by heating the air, as patented by James B. Neilson, of Glasgow, in 1828, and first used in practice at the Clyde works in 1829. With a hot blast, the use of coal or anthracite instead of coke, which substitution had been attempted unsuccessfully in 1804, became possible and was first adopted by the Clyde works in 1831, another application being made in 1839 at Yniscedwyn, near Swansea (Wales).—Stahl und Eisen.

Chief Engineer Isham Randolph, of the sanitary district of Chicago, has issued an official statement regarding the receipts and expenditures to date with the estimated amounts required for future work. The total amount expended for all accounts is $22,591,801.85. The total cost of future construction work is estimated at $4,372,635, and the total requirements, including interest, land and administration, to January 1, 1899, is $10,538,436.94. The total resources in sight to that date are $6,833,561.24, leaving a deficit on the requirement to January 1, 1899, of $3,704,875.70. Of the contracts for construction, a percentage of 93·42 has been earned.

There have been built in the United States in 1896, 33,000 cars more than the total of two years ago, yet the total is still below the lowest of any year before 1894, for which we have figures that are comparable. These go back to 1888, and the lowest total in that period is in 1893, when 56,900 cars were reported built, or about 6,000 more than in 1896. But one of the large companies, whose output is included this year, did not report in 1893, so that the difference is actually larger. Comparing with 1890, the best year for car building in the last decade (the best for locomotive builders also), we find that the 1896 output was not half that of the earlier year, when 103,000 cars were built. In both 1891 and 1892 also the contracting shops turned out within 4,000 of 100,000 cars.

In a paper recently read before the Société Technique by M. Ravel, says the Practical Engineer, the author stated that acetylene kindles at about 900° Fah., while other inflammable gases fire at about 1,100° Fah. Explosive mixtures of acetylene can be readily exploded by inclosing them in glass tubes and heating them over a spirit lamp; the mixture explodes before the glass is softened. He said the temperature produced by the explosion of acetylene is over 7,200° Fah., while that of the oxyhydrogen blowpipe is not more than about 5,400° Fah. This high temperature, together with the small amount of water vapor produced, makes the explosion of acetylene a very violent one, which breaks a bottle that gas and air mixtures cannot break. The flash produced is a blinding one, and it is very dangerous to bring a flame near a leakage of acetylene. Then the ease of lighting and the force of explosion promised to render acetylene very useful in gas engines. Tests were therefore made. The engine at first made a series of loud, sharp explosions which threw the indicator level out of gear. The lubrication had to be doubled, and the degree of cooling had a great deal more influence on the efficiency than when coal gas was used. The indicated work falls off with the proportion of acetylene. As the acetylene is increased the initial pressure rises, but the fall of pressure is immediate and the expansion is not kept up. As the acetylene approaches 5 per cent. the explosions become destructive, and there seems to be internal vibrations in the mixtures in the cylinder. Diminishing the compression, these vibrations are less and the work done is greater. The work done is then about 2·1 times as great as can be obtained from an equal volume of coal gas. Acetylene cannot be advantageously used in motors as at present constructed, for either it has to be too much diluted or else the explosion is too sharp.

ELECTRICAL NOTES.

The largest telephone exchange, accommodating 10,000 subscribers, has been recently completed in Hamburg, Germany. No other exchange has more than 6,000 connections.—Elektrotechnische Rundschau.

An electrical exhibition is to be held at Como, Italy, in 1899, to celebrate the centenary of the Volta pile. Turin is to have a similar exhibition in 1898. The great trouble is, says a contemporary, we don't have electrical exhibitions enough.

A German contemporary of the Electrical World, referring to Mr. Preece's proposal to drop the use of the horse power as a unit, and to call a kilowatt hour a "kelvin," remarks that the German equivalent for this latter unit (Kilowattstunde) is inconveniently long. The same page speaks of "Sicherheitsvorschriften für Hochspannungsanlagen."

Arrangements have, it is said, been made by the London Electrical Cab Company to place a large number of electrical cabs, at an early date, for hire in the streets of London. The cabs will, it is said, be made on the Mulliner system; will be four wheeled vehicles, with a new form of body, which gives the rider a clear look ahead. Secondary batteries will be employed.

Telephoning to a submarine diver is a recent electrical achievement. The experiment was tried at the wharf of the Chapman Wrecking Company, in New York City, on April 1, by Mr. H. T. Atkinson, engineer of the New York Telephone and Telegraph Construction Company, and Capt. C. P. Everett, who was the diver. In the diver's helmet were placed a small battery of six cells, a transmitter and a receiver, the latter being adjusted to his ear. When the diver was in 40 ft. depth of water conversation could be carried on between him and people on the shore with great distinctness.

The theory of the earth as a conductor is discussed in a recent issue of the American Electrician by Dr. Bell, and the conclusion arrived at that the conductivity of the earth is so meager that, except in the case of very high voltages or very minute currents, it is quite insignificant in practical affairs; in railway return circuits the earth return does much more harm than good; for power service the earth is useless as a return, and in telegraphy alone does it appear likely to serve a permanently useful purpose. This is in marked comparison with the idea formerly prevalent and used in the calculation of ground return circuits, that the conductivity of the earth is infinite.

The United States and Hayti Telegraph and Cable Company, the latest of the cable corporations with which the Commercial Cable Company has intimate connections, establishes a new route from New York to the West Indies and South America. The new cable approaches New York by way of Coney Island and Brooklyn. The office of the company is at No. 1 Broad Street, where the Commercial Cable Company has its office, and messages will also be accepted at all the Postal Telegraph Company's offices throughout the country. Peculiar interest attaches to the completion and opening of this cable, from the fact that the Attorney General of the United States applied to the United States Court for an injunction to prohibit the company from prosecuting its project. The Attorney General alleged that the company was a mere cloak for the operations of a foreign company. The United States and Hayti Telegraph and Cable Company replied, denying the allegation and declaring itself a bona fide American company, and that its object was to establish a competing service and to largely reduce the heretofore exorbitant rates charged by the existing monopoly. The company has issued a schedule of reduced rates.

A break in the cable laid between the Senegal coast of Africa and Pernambuco in Brazil five years ago has led to an extraordinary discovery, related recently by Mr. Benest to the Institution of Electrical Engineers. The cable was as fine a one as modern methods could devise, yet after three months it broke about 150 miles from the African coast; it was repaired and broke again. It was then found that at the place where the break occurred there was a great deal of vegetable growth resembling river weed; that the color of the sea was a dirty brownish green, indicating the presence of fresh water, and birds' feathers, pieces of orange peel, scraps of carpet, and bits of driftwood were drawn from the bottom of the ocean. The phenomenon was purely local, as the nearest river was seventy-five miles away and discharged its water in a different direction. It was surmised that it meant the sudden breaking through of a submarine river, and the cable was moved to a distance; after two years it broke again and was moved once more, and engineers are waiting to see what will happen. Submarine rivers are known to exist in other parts of the ocean, off the mouth of the Congo and in the Gulf of Carpentaria, for instance. This explanation, however, does not account for the carpet and the orange peel.

When arc lights were first introduced for street lighting, there was a very exaggerated idea of their lighting power. A light of 1,000 candle power seemed such a powerful illuminator that the idea was very naturally conceived of placing lamps on the top of tall towers and lighting the whole area of a city. Several municipalities adopted this tower system of lighting, of which the best known example is doubtless Detroit. It was at once found, however, that a cluster of arc lamps 150 ft. or more from the ground might be an excellent plan for lighting the whole of a large area; but was a very poor plan for lighting city streets. In the average American city, with long blocks, the streets comprise not more than one-third of the area. Hence with the tower system of lighting 66 per cent. or more of the illuminating power is wasted in lighting up house roofs, back yards and vacant lots. Nearly every city of which we have information that originally adopted the tower system of lighting has abandoned it. It is therefore quite surprising to learn that Des Moines, Ia., proposes to put in a municipal street lighting plant and to use the tower system. What consideration influenced the city authorities to adopt this system, we do not know, but we would strongly urge them, says Engineering News, to investigate the experience of Detroit and other cities with the tower system of lighting before they construct such a plant in their own city.

MISCELLANEOUS NOTES.

France has set up about 300 monuments to more or less distinguished Frenchmen during the last twenty-five years, and there are now 127 committees collecting money for more.

A civil engineer, mechanical engineer or architect in the employ of the German railways must on an average wait till he is 38 or 40 years old before his position is permanent. The average time they are employed on temporary work before they are permanently appointed is twelve years.—Glaser's Annalen.

The proportion of designs registered to total number of applications is as follows, according to statistics published in La Propriété Industrielle: United States, 75 per cent.; England, 94 per cent.; France, 100 per cent.; Belgium, 100 per cent.; Brazil, 100 per cent.; Italy, 91 per cent.; Portugal, 33 per cent.; Servia, 100 per cent.; Switzerland, 99 6-7 per cent.

The percentage of patents issued to the total number of applications is about as follows, according to statistics published in La Propriété Industrielle: United States, 53 per cent.; England, 48 per cent.; France, 97 per cent.; Belgium, 99½ per cent.; Brazil, 89 per cent.; Denmark, 55 per cent.; Spain, 90 per cent.; Italy, 92 per cent.; Norway, 75 per cent.; Portugal, 100 per cent.; Sweden, 56 per cent.; Switzerland, 90 per cent.; Tunis, 100 per cent.

The proportion of trade marks registered to total number of applications is about as follows, according to statistics published in La Propriété Industrielle: United States, 88 per cent.; England, 32 per cent.; France, 100 per cent.; Belgium, 100 per cent.; Brazil, 100 per cent.; Denmark, 98 per cent.; Spain, 72 per cent.; Italy, 92 per cent.; Norway, 96 per cent.; Holland, 95 per cent.; Portugal, 90 per cent.; Servia, 100 per cent.; Sweden, 82 per cent.; Switzerland, 94 per cent.; and Tunis, 100 per cent.

A company of glassworkers have recently discovered that ordinary plate glass will make a more durable monument than the hardest marble or granite, for glass is practically indestructible. Wind, rain, heat or cold will eventually crumble the hardest rock, and one can seldom read the inscription on a gravestone fifty years old, but a glass monument will look as fresh after the lapse of centuries as on the day of its erection, and the inscription can be made ineffaceable. The thick plate glass used to glaze the port holes of steamers will resist the stormiest sea, and is practically unbreakable.

The number of patents, designs and trade marks secured annually is at present about as follows:

	Patents.	Designs.	Trade Marks.
United States	40,000	1,100	1,800
England	12,000	20,000	3,000
France	10,000	50,500	7,900
Belgium	5,700	150	700
Italy	2,400	60	220
Switzerland	1,850	56,000	750
Spain	1,300	....	450
Sweden	850	....	250
Norway	660	....	140
Denmark	350	....	190
Brazil	300	180	160
Portugal	120	165	100
Tunis	35	....	25
Holland	....	....	500
Servia	....	5	75

—La Propriété Industrielle.

What is to be known as a long distance telescope has been adopted by the Admiralty for use in the navy, and one of these instruments will be supplied to each seagoing battleship and cruiser, and to each vessel of smaller type commanded by an officer not below the rank of commander. This special telescope is only intended for use at sea on occasions when it is necessary to make out distant signals or objects, and as its size and weight necessitate its being used from a tripod, the Admiralty have directed that it is to be used in some suitable place where an all-round view can be obtained, and where the tripod supplied with it can stand firmly. In the case of flagships fitted with an after signal tower an additional telescope of this description will be supplied for the use of the admiral's immediate staff. For several months experiments have been carried out in the flagships of the Channel and Mediterranean squadrons with the long distance telescope. The results, however, were not regarded as satisfactory, as the magnifying process had been carried to such an extent as to obscure the vision. It is claimed for the type now to be adopted that this difficulty has been overcome. The Naval and Military Record says that one great drawback against the use of the tripod is that it renders the telescope practically useless if the vessel is steaming fast, in consequence of the vibration of the ship. Up to the present no alternative means of using the instrument has been suggested.

The production of aluminum for 1896–97 is about 2,000 tons, the various countries contributing as follows:

	H. P.	Daily Output in Pounds.
United States:		
Niagara Falls, N. Y	1,600	2,400
New Kensington, Pa	1,600	2,000
Switzerland:		
Neuhausen	4,000	5,000
France:		
La Praz	2,500	3,000
St. Michel	2,000	2,500
Total	11,700	14,900

The following additions are contemplated for 1897–98:

	H. P.	Daily Output in Pounds.
United States:		
Niagara Falls, N. Y	5,500	7,000
Switzerland:		
Rheinfelden	6,000	8,000
France:		
St. Michel	2,000	2,500
Great Britain:		
Foyers Falls	3,000	4,000
Norway:		
Sarpsfos Falls	5,000	6,500
Total of additions	21,500	28,000
Total for 1897–98	33,000	42,500

Total production for 1897–98, 5,790 tons.

[Continued from Supplement, No. 1113, page 17792.]

THE EVOLUTION OF THE AMERICAN LOCOMOTIVE.

By Herbert T. Walker.

Fig. 14 illustrates the Sandusky, the first locomotive built at the famous Rogers Locomotive Works, Paterson, N. J. At that time the name of the firm was Rogers, Ketchum & Grosvenor, and its founder, Thomas Rogers, designed this engine. The late Zerah Colburn remarked that "Thomas Rogers may be fairly said to have done more for the modern American locomotive than any of his contemporaries."

The Sandusky ran its trial trip from Paterson to Jersey City and New Brunswick and back October 6, 1837, its performance being entirely satisfactory. It was intended for the New Jersey Railroad and Transportation Company, but was, however, bought for the Mad River and Lake Erie Railroad by its president, Mr. J. H. James, of Urbana, O. It continued in service many years. The cylinders were 11 in. in diameter by 16 in. stroke. Driving wheels 4 ft. 6 in. diameter; truck wheels 2 ft. 6 in. diameter. The general design did not differ materially from the Experiment (Fig. 11), but it is of interest as being the first locomotive with weights on the driving wheels to counterbalance the cranks and connecting rods. For this Mr. Rogers filed a specification in the Patent Office dated July 12, 1837, in which he says, "The irregular motion which arises from not having the cranks and connecting rods balanced is attended with much injury to the engine and to the road, and with much loss of power." The driving wheels were of cast iron, with hollow spokes and rims, which at that time was a remarkable novelty. The section of the spokes was of oval form, and the rim of very much the same shape as that which is in common use to-day. In order to counterbalance the parts referred to, the rim of the wheel opposite the crank was cast solid. The importance of counterbalancing was not recognized until several years after it had been introduced by Mr. Rogers, but to-day it would be hard to find a locomotive without counterbalanced driving wheels.

Another sporadic form of locomotive engine was built by Gillingham & Winans, of Baltimore, for the Baltimore and Ohio Railroad, in the year 1838. They had upright boilers, but the cylinders were horizontal and were connected to cranks on an intermediate shaft, which was geared to a second shaft having outside cranks to which the four driving wheels were coupled. These engines were of ungainly form and were nicknamed "crabs," but in the year 1844 Mr. Winans brought out another class of engine retaining substantially the same system of gearing but with eight coupled wheels instead of four, and a horizontal boiler. These engines were ignominiously named "mud diggers," but they did heavy freight service on the Baltimore and Ohio Railroad for many years.

At this period it will be necessary to revisit England to see what was going on in the shops of Robert Stephenson & Company, Newcastle upon Tyne, in 1842. In that year it appears that the link motion was reinvented without previous knowledge of James' invention. William Howe, a mechanic employed in Stephenson's shops, decided to place a curved link between the eccentric rods to take the place of the Stephenson "fork motion," then in general use. He made a pencil sketch and wooden model which were shown to Robert Stephenson, who, seeing its merits, ordered it to be fitted to all engines constructed at his works, and from that time it has been known as "Stephenson's link motion." The first engine equipped with this gear was No. 71, for the North Midland Railway, and commenced to run September 10, 1842. There was a dispute between Howe and an apprentice named Williams, who claimed to have a share in the invention, but as we have not space to enter into the details of the controversy, the reader is referred to Colburn's "Locomotive Engineering," where the matter is very ably dealt with.

But not even when the link was being used with such remarkable success in England did American engineers recognize its merits, and it was not until 1847 that it was adopted in this country. In the year 1849 Mr. Thomas Rogers introduced it in his practice, fitting a stationary link motion to some engines for the Hudson River Railroad. In this arrangement the curve of the link was convex toward the eccentrics, instead of concave, as in the Stephenson gear, and the link was suspended on a fixed center, the valve rod block being moved up and down instead of the link. This plan was introduced by Sir Daniel Gooch, master mechanic of the Great Western Railway, of England, about the year 1845. In 1850 Mr. Rogers commenced to build engines with the shifting link motion, and soon afterward it came into general use. Other builders, however, strenuously resisted the innovation, and none more so than Mr. Baldwin, who could not be induced to adopt it until the year 1854, when he fitted the link to the Pennsylvania, an engine for the Central Railroad of Georgia.

The next example of progress in locomotive construction is illustrated in Fig. 15, which shows a very good engine designed by Mr. Rogers and built at his works, in 1845, for the Hartford and New Haven Railroad. It had equalizing levers between the driving wheel springs, which do not show in the drawing. The truck had side bearings and springs on the sides of truck. The pumps had short stroke and were worked from the crosshead as shown. The cylinders were 11⅛ in. diameter by 18 in. stroke. Driving wheels 5 ft. diameter. We notice the supplemental frame that supports the running board. It illustrates the transition from outside to inside framing. The frames were of bar iron and the reversing gear was the hook or fork motion.

The writer has not succeeded in discovering when the first sand boxes were used. The early locomotives were without them. When the engine slipped, the fireman jumped down and threw some gravel on the rails with his shovel, or, failing that, he used the pinchbar, with verbal encouragements, more powerful than polite, from the engine driver. The next step appears to have been a bucket of sand carried on the foot board, and scattered by hand when required. Mr. Baldwin commenced to place sand boxes on his engines in the year 1846 for the Philadelphia and Reading Railroad. The chief objection to sand is that, while it prevents the driving wheels from slipping, it has a retarding effect on the train wheels, which, with a heavy load on a hill, is a very serious drawback. To overcome this, a jet of steam or water has been tried, and with a measure of success, as it is well known that thoroughly wet rails will give almost as good adhesion as when they are perfectly dry. An electric current has been passed through the driving wheels and rails to prevent slipping; but none of these devices are equal to good dry sand.

In the year 1846, Septimus Norris, a brother of William Norris, patented a ten wheel freight engine with six driving wheels combined with a leading truck. Several of these were built for the Philadelphia and Reading Railroad.

An interesting locomotive is illustrated by Fig. 16, which shows one of a class built at the Norris Works about the year 1847, for the Camden and Amboy Railroad. There were several of these engines built, most of them having driving wheels 8 ft. in diameter and cylinders variously 13 in. by 34 in., 13 in. by 38 in. and 14 in. by 38 in. stroke. Their weight was about 22 tons in working trim. This type of engine has the driving wheels behind the firebox and is known as the "Crampton" class, having been patented in 1843 by the late Thomas Russell Crampton, an English engineer of some distinction. He did not, however, originate the idea, as Baldwin built engines with the driving wheels behind the firebox in the year 1833. The advocates of this class of engine claimed that it admitted of driving wheels of practically unlimited diameter, while the boiler could be dropped down to the axles of the carrying wheels, thus enabling an engine with large driving wheels to have a low center of gravity, which was at that time and for years afterward considered necessary for safety at high speeds. Crampton engines never came into general use anywhere except in France, where the "système Crampton" was very popular and it is believed that some of the engines are still running.

Referring to the example before us (Fig. 16), we are informed that these engines made steam slowly, which was probably caused by the fact that the boilers were small compared with the immense cylinders and driving wheels. Another drawback to them was that they lacked adhesive weight, having only about 8 tons on the driving wheels; it was, therefore, hard to start them with a train, although when under headway they occasionally covered a mile in 53 seconds. But the most serious objection to them was their tendency to run off the track when traveling fast, the chief reason being that the propelling mechanism at the rear end, with unbalanced driving wheels, caused the front end to "nose" or oscillate laterally. It will be observed that the driving wheels had a wood filling between the spokes to prevent "raising dust."

Fig. 17 illustrates a fine engine designed by Mr. McQueen for the Hudson River Railroad (now a part of the New York Central and Hudson River Railroad). It is interesting not only for the excellence of the design, but because it was one of the first engines to do regular everyday express work on the road that now claims to have the fastest regular train in the world. It appears that the Hudson River steamboats, even as far back as 1845, offered great inducements to travelers by reason of their luxurious accommodation and high speeds, and these express trains were put on to compete with them. A writer in the Practical Mechanic's Journal of 1850-51, in describing this engine, said: "The usual speed of railroads was not so much greater as to induce the passengers to leave the magnificent floating palaces. Great speed must, therefore, be determined on." The result was the Champlain, which commenced working the express trains between Thirty-first Street, New York, and Poughkeepsie, 72 miles, in December, 1849. The distance was covered in 2 hours 25 minutes = 29·79 miles an hour, including twelve stops. The weight of the trains averaged 94 tons, exclusive of engine and tender. The ordinary trains did the same distance in 2 hours 45 minutes.

The Champlain had cylinders 15 in. in diameter by

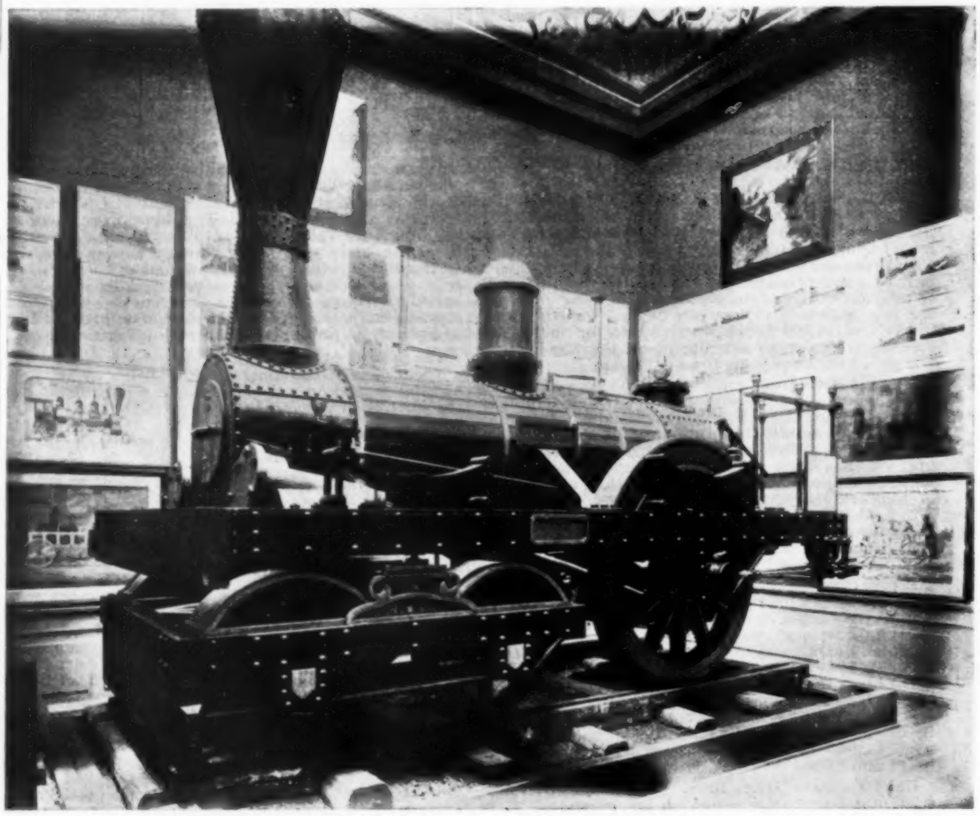


Fig. 14.—ROGERS' SANDUSKY, 1837—FIRST ENGINE WITH A DRIVING WHEEL COUNTERBALANCE.

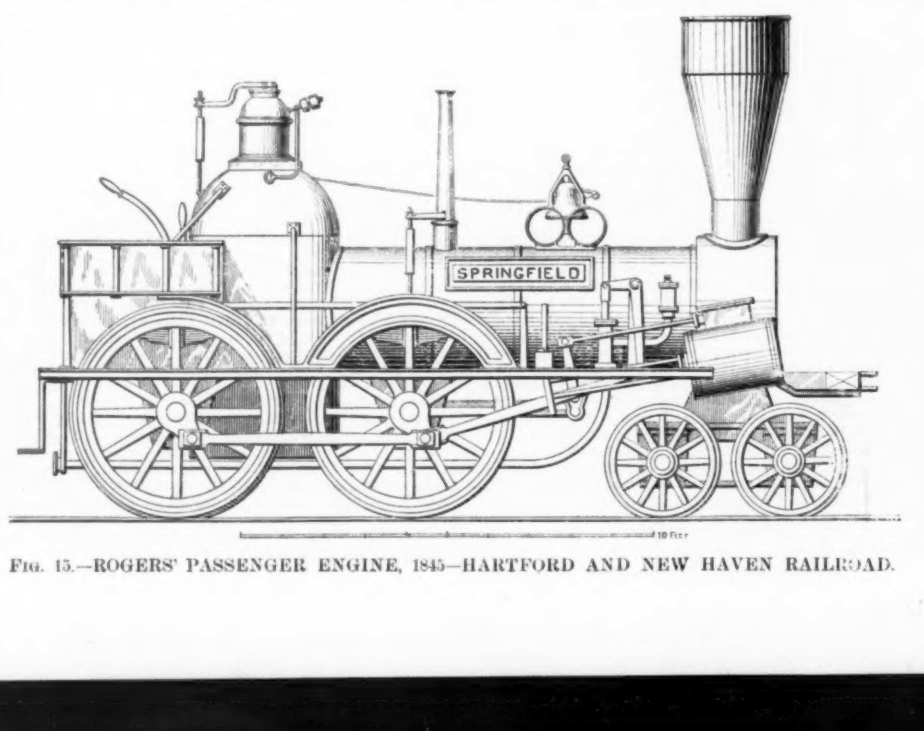


Fig. 15.—ROGERS' PASSENGER ENGINE, 1845—HARTFORD AND NEW HAVEN RAILROAD.

20 in. stroke. Steam ports, 14 in. by 1 in. Exhaust port, 14 in. by 2 in. Driving wheels, 5 ft. 6 in. in diameter. Heating surface of firebox, 79·43 sq. ft.; of tubes, 824·43 sq. ft.; total heating surface, 903·86 sq. ft. Gross weight of engine, 23½ tons. The frame was a curious example of the transition from plate to bar, it being made of two plates with a square bar riveted between. The plates were 5 inches deep.

There were two slide valves in the steam chest; the upper one was a cut-off valve to enable the steam to be worked expansively, and it moved on a fixed perforated plate immediately over the main valve. The former was worked from a return crank on the crankpin; the main valve was worked from the eccentrics with the V hook motion commonly used at that period. The throw of the main valve was 3⅛ in. with ⅝ in. lap, and set with a lead of $\frac{3}{16}$ in. The expansion valve cut off at half stroke.

Referring back to Fig. 12, it will be seen that Campbell's engine, although it has the Stephenson firebox, four coupled driving wheels, with cylinders connected to the forward pair, and a leading truck, does not possess all the essential features of the modern locomotive, because the frames are outside and of plate iron and wood. The cylinders are inside connected, and it has no equalizers. Fig. 13 has outside cylinders, leading truck, inside frames and equalizers; but the frames are of plate iron and wood, the cylinders are connected to the rear driving wheels, and the firebox is of the Bury pattern. Fig. 15 has the bar frame, and begins to look more like an American engine, having the equalizers and the cylinders connected to the forward driving wheels; but the cylinders are inclined, and the outside frame for the running board and objectionable Bury firebox are still retained, and the reversing gear is the hook motion. Engineers up to that time were afraid of spreading the truck wheels too far apart; hence the necessity of inclined cylinders; but in 1850 Mr. Rogers designed a spread truck, which permitted the cylinders to be dropped down to a horizontal line, and in the same year the wagon top boiler was introduced in the practice of the Rogers Locomotive Works; and so we have in the year 1853 an engine possessing all the essential features of a modern American locomotive, which is shown in Fig. 18. It had the Stephenson firebox, with the peculiar inclined or tapered joint between it and the barrel of the boiler, making what is known as the wagon top boiler. The latter was an American invention. A large number of these engines were built by Mr. Rogers for various railroads. They had the link motion. The cylinders were 16 in. diameter by 22 in. stroke, and the driving wheels were 5 ft. in diameter, although the size of the latter was varied in different engines.

In 1857 Mr. Bissell patented a four wheeled truck, having its frame extended rearwardly and pivoted to the engine frame. The truck, therefore, swung from this pivot instead of on a central pin, and the engine rested on a pair of V shaped inclined planes midway between the two axles. The inventor claimed that a truck on his plan adjusted itself to the curvature of the track better than one of the ordinary plan. Mr. Hud-

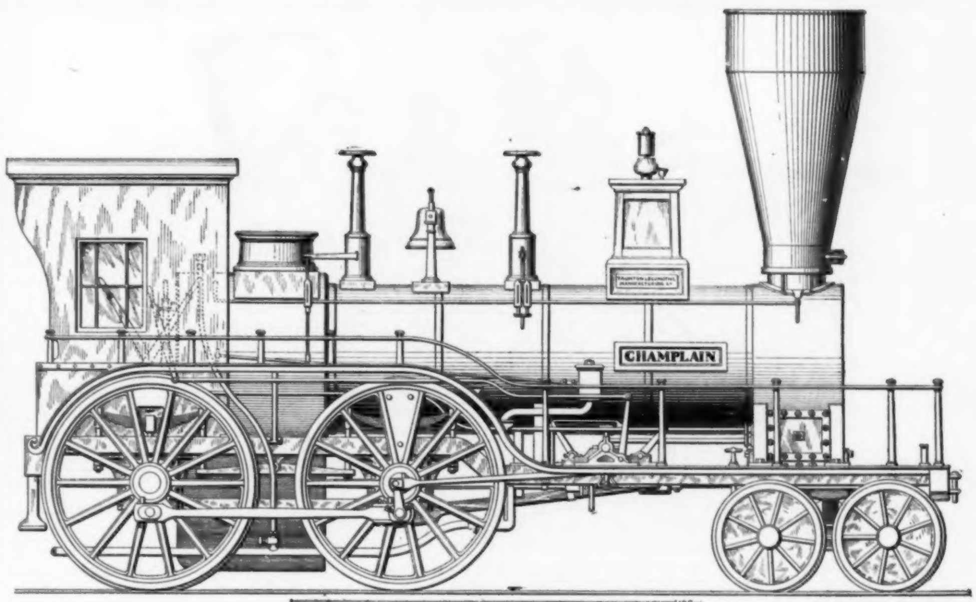


FIG. 17.—EXPRESS ENGINE, HUDSON RIVER RAILROAD, 1849—AN ORIGINAL NEW YORK CENTRAL FLIER.

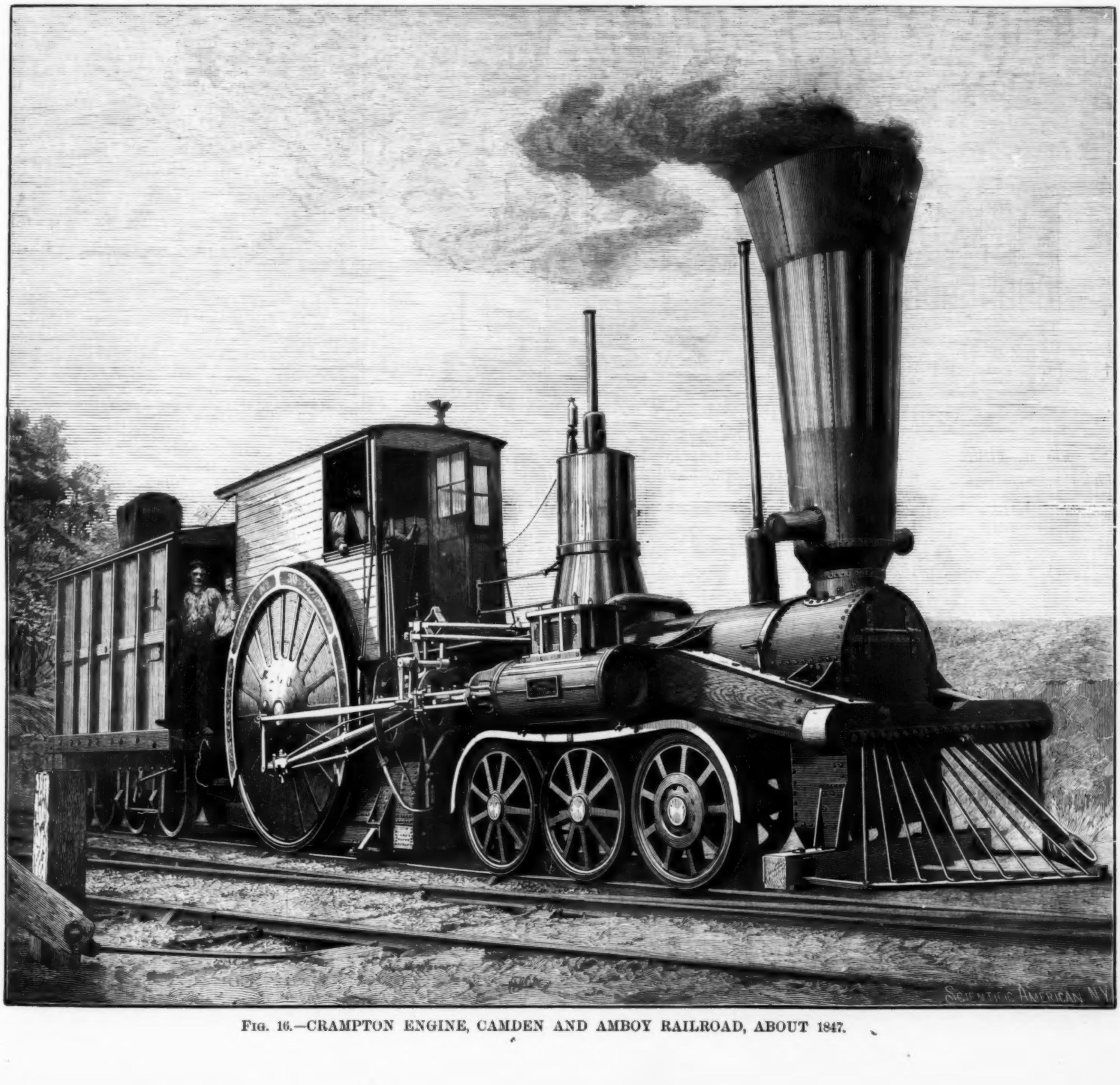


FIG. 16.—CRAMPTON ENGINE, CAMDEN AND AMBOY RAILROAD, ABOUT 1847.

son, of the Rogers Locomotive Works, was one of the first to recognize the value of Bissell's invention, and applied it to a locomotive in 1858. In the same year Bissell patented the single axle or pony truck, as it is often called. This was constructed on substantially the same principle as his four wheeled truck and is now in common use.

On the death of Mr. Rogers, which occurred in 1856, the business of Rogers, Ketchum & Grosvenor was re-organized under the title of the Rogers Locomotive and Machine Works, and Mr. William S. Hudson was appointed superintendent. Mr. Hudson was a pupil of George Stephenson's, and was one of the foremost locomotive engineers of his day. Under his supervision, the first Mogul engine, Fig. 19, built at the Rogers works, was completed in 1863 for the New Jersey Railroad and Transportation Company, now the New Jersey part of the Pennsylvania Railroad. This engine had six coupled wheels and the Bissell pony truck previously described, with swing links patented by Mr. Alba F. Smith, and also an equalizing lever from the truck to the springs of the forward driving wheels. This equalizing arrangement was invented and patented by Mr. Hudson. The cylinders were 17 in. diameter by 22 in. stroke. Driving wheels 4 ft. 6 in. in diameter. Weight about 35 tons. A very large proportion of the weight of a Mogul engine rests on the driving wheels, which makes it the most useful and popular freight engine of to-day.

The rapid increase of traffic during the period under notice demanded a still more powerful freight engine, and in order to secure the necessary amount of adhesion, Mr. Alexander Mitchell, master mechanic of the Lehigh and Mahoning Railroad, designed in the year 1866 an eight coupled engine, and it was named Consolidation. This name was suggested by the consolidation of the Lehigh and Mahoning with the Lehigh Valley Railroad, which had just then been consummated. This historical locomotive is shown in Fig. 20, and it is interesting to note that both the Mogul and Consolidation engines of the present day have not been altered in any essential particular except in dimensions, which reflects great credit on their designers. The Consolidation was built at the Baldwin Locomotive Works, and its principal dimensions were: Cylinders, 20 in. diameter by 24 in. stroke; driving wheels, 48½ in. in diameter. The pony truck was equalized with the front driving wheels. Weight about 45 tons. The boiler was fed by one injector and two feed pumps; the latter were worked by return cranks on the rear driving wheels, as shown. Pumps have now practically become obsolete. They gave much trouble by freezing in cold weather, and many vexatious delays were caused by "failure of the pumps."

Mr. H. J. Giffard, a French engineer, discovered that the motion imparted by a jet of steam to a surrounding column of water was sufficient to force it into the boiler from which the steam was taken. In July, 1858, he patented his invention of the injector, and the various inspirators now in general use for supplying steam boilers with water are all constructed on the model of the Giffard injector.

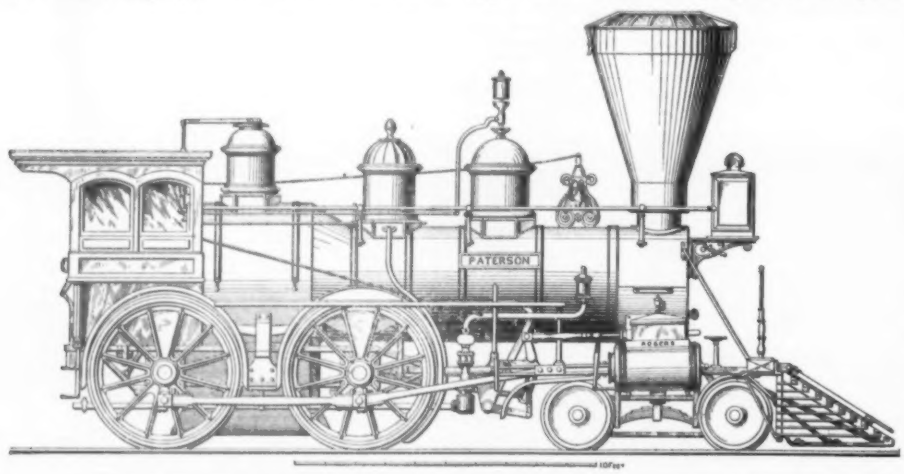


FIG. 18.—ROGERS' STANDARD PASSENGER LOCOMOTIVE, 1853, HAVING ALL THE ESSENTIAL FEATURES OF A MODERN AMERICAN ENGINE.

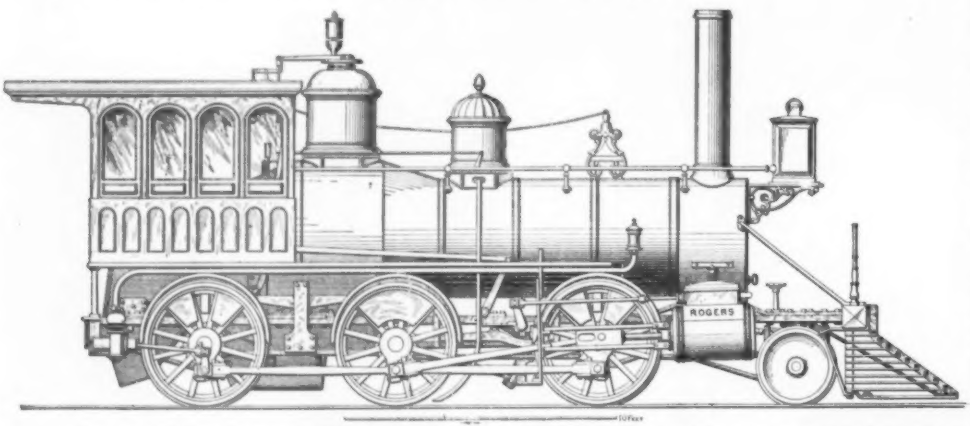


FIG. 19.—FIRST MOGUL ENGINE, BUILT AT THE ROGERS WORKS, 1863—NEW JERSEY RAILROAD AND TRANSPORTATION COMPANY.

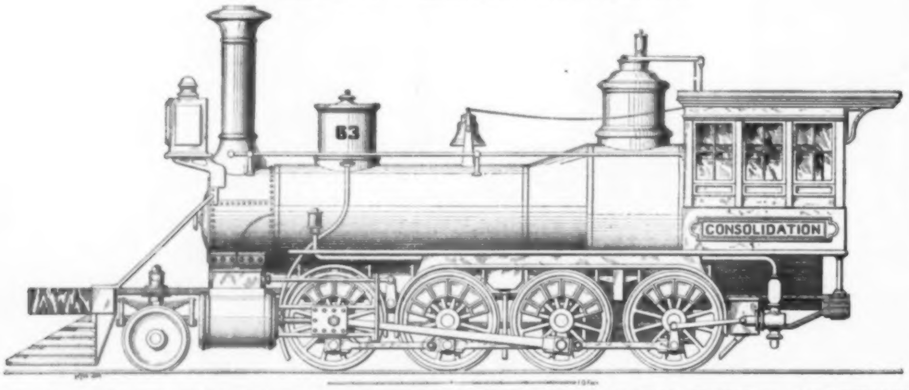


FIG. 20.—FIRST CONSOLIDATION ENGINE, BUILT AT THE BALDWIN WORKS, 1866—LEHIGH VALLEY RAILROAD.

In these days of "continuous brakes," it seems remarkable that the early locomotives were absolutely without any retarding mechanism; and even down to the medieval period of railway history, the fastest English trains were run with only a hand brake on the tender, and a similar brake, worked by the guard, in the brake van. When the tender weighed only 10 or 15 tons and the brake van less, this system was wofully inadequate, and many frightful accidents resulted. American trains were far better equipped in this respect, and at a very early period all our cars, both freight and passenger, were provided with hand brakes. In the year 1833, Robert Stephenson patented a steam brake for locomotive engines, and in the following year the device was applied to an engine on the Liverpool and Manchester Railway. It was successful, but, like the link motion, never came into general use until years afterward, when the so-called "steam driver brake" was introduced, being substantially the same as Stephenson's design of 1833.

As we have not space to examine the numerous forms of power brakes that have come and gone during the last fifty years, it will suffice to say that the invention of continuous brakes, which act on all the wheels of the train simultaneously, is the most important one of modern times, inasmuch as their adoption has not only rendered possible the present high speeds, but has done more in the way of saving life and property than any other invention connected with railways.

Various systems of steam, hydraulic and vacuum brakes have been tried, and also brakes applied by the inertia of the moving train with more or less success, but it appears that brakes worked by air pressure are the most efficient and reliable.

George Westinghouse, Jr., introduced his continuous air brake in 1869 upon a train on the Pittsburg, Cincinnati, Chicago and St. Louis Railway running out of Pittsburg. The brake was non-automatic, but in 1873 he made a very important improvement by placing his automatic brake on the Reading Railway. In this arrangement all the brakes are automatically applied if the train parts or any of the cars run off the rails. The original automatic system has, however, been supplanted by the quick action automatic brake, introduced by Mr. Westinghouse in 1886, which makes the use of air brakes possible on long freight trains, so that a train of 50 standard freight cars, having a total weight of nearly 2,000,000 pounds, measuring over 1,960 feet in length and traveling at the rate of 37 miles an hour on a level, can be stopped in the remarkably short time of 15 seconds without skidding the wheels. In a separate test to show the rapidity of application, it was found that the brakes went fully on within two seconds from the time the engine driver opened his brake valve. This system is undoubtedly the best in the world, and does great credit to Mr. Westinghouse.

It now only remains to glance at a few locomotives of modern construction, as there is practically no difference between the engines of to-day and those already described, except in dimensions and weight.

As in 1836 it was found necessary to build four coupled engines for heavy freight service, so, about fifteen years ago, six coupled engines for heavy passenger service came into the field, and it is a noteworthy fact that the fastest speed ever recorded was attained by a six coupled passenger engine, No. 564, on the Lake Shore and Michigan Southern Railway, October 24, 1895, when a special train, weighing 304,500 lb., was conveyed from Erie to Buffalo Creek (86 miles) in 1 hour 10 minutes 46 seconds = 72·92 miles an hour. During this trip 33 consecutive miles were made at the rate of 80·6 miles an hour, 8 miles at 85·44 miles an hour, and 1 mile was covered at the rate of 92·3 miles an hour. This engine weighs 56¼ tons, it has a leading four wheeled truck, the cylinders are 17 in. in diameter by 24 in. stroke, and six driving wheels, 5 ft. 6 in. in diameter, which, at 92·3 miles an hour, would make 469 revolutions per minute. The engine was built by the Brooks Locomotive Works, Dunkirk, N. Y.

The left hand portion of Fig. 5 shows the celebrated "999," on the New York Central and Hudson River Railroad. It is the latest development of the American eight wheeled locomotive, and the picture gives a good idea of the grandeur and beauty of its proportions, when compared with the De Witt Clinton. It was designed by Mr. William Buchanan, chief of motive power of the above named railroad. The center line of the boiler is no less than 8 ft. 11½ in. from the rails, and it is remarkably steady at the highest speeds.

The Empire State Express covers 440 miles in 8¼ hours = 53·33 miles per hour, including four stops, and this engine hauls the train over a portion of the route. It was exhibited with the De Witt Clinton at the Columbian Exposition, and a comparative table of the dimensions of the first and latest New York Central engines will be of interest.

This article would be incomplete without touching on "compound" locomotives. To those who are not familiar with the subject, it will be well to explain that in ordinary or "simple" engines, the steam, after having done its work in the cylinders, is released through the exhaust pipe into the chimney; but in a compound engine, the steam from the boiler is admitted to one cylinder only, called the "high pressure" cylinder, and at the end of the stroke is exhausted to the next cylinder, called the "low pressure" cylinder, and from thence through the exhaust pipe to the chimney in the usual way. The steam is thus made to do its work twice over by virtue of its expansive force. Broadly speaking, compound locomotives may be divided into three classes, viz., those having two, three and four cylinders. Some very good two cylinder compound

Engine.	Tubes.		Diameter of driving wheels.	Diameter and stroke of cylinders.	Weight of engine and tender.	Total heating surface.	Boiler.			Wheel base.
	No.	Diameter.					Height of center from rails.	Diameter.	Working pressure.	
De Witt Clinton....	30	2½ in.	4 ft. 6 in.	5½ in. by 16 in.	6 tons	Square ft. 131·6	3 ft. 9½ in.	2 ft. 7¾ in.	80 lb.	6 ft. 0 in.
999...................	208	2 in.	7 ft. 2 in.	19 in. by 24 in.	102 tons	Square ft. 1930·37	8 ft. 11½ in.	4 ft. 10 in.	190 lb.	23 ft. 11 in.

have been built by the Richmond Locomotive Works, which show an economy of fuel consumption of about 25 per cent. A fine two cylinder compound engine, No. 1, may be seen every day working in the Grand Central Station yards in this city. It was designed by Mr. William Buchanan, and is doing good service. A large number of three cylinder compounds are running on the London and Northwestern Railway, of England, designed by the locomotive superintendent of that line, Mr. F. W. Webb. These engines show a saving of fuel of about 25 per cent.

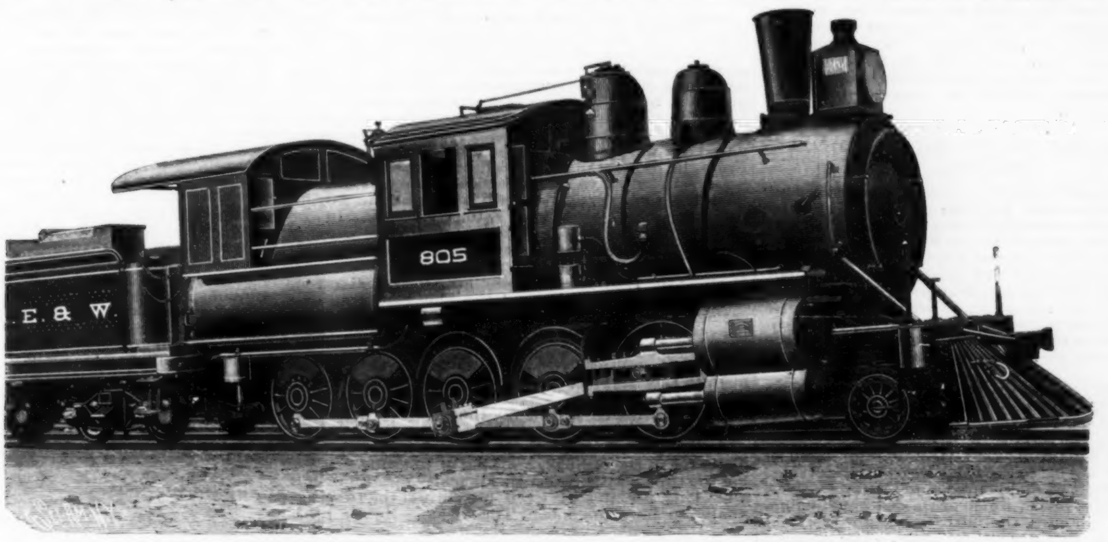


FIG. 21.—FOUR CYLINDER COMPOUND DECAPOD FREIGHT LOCOMOTIVE, 1893.

Weight of engine alone, 96 tons; hauling capacity, 4,600 tons; cylinders, 16 inches and 27 inches by 28 inches; heating surface, 2,443 square feet; steam pressure, 180 pounds.

Fig. 21 illustrates one of the best examples of a four cylinder compound locomotive. It is of the Vauclain type, and was built by the Baldwin Locomotive Works for the New York, Lake Erie and Western Railroad for heavy freight service.

The cylinders are arranged in pairs, the piston rods engaging a common crosshead. The cylinders are 16 in. and 27 in. in diameter by 28 in. stroke. The engine alone weighs 96 tons and has a hauling capacity of 4,600 tons on a level. It is worth while to compare this with the load drawn by the first Baldwin engine, Fig. 10.

It may be remarked that engineers are much at variance on the question of compound locomotives; many men of the highest standing, while admitting that a certain success has been attained by compound engines, maintain that the economy in fuel is counterbalanced by the disadvantages inherent to the greater complication of machinery and by the extra cost for repairs. Notwithstanding this, it seems probable that the compound engine is the locomotive of the future, and that of the two cylinder type, as being the least complicated and costly.

The writer takes pleasure in thanking Mr. J. Elfreth Watkins, curator of the National Museum, Washington; Mr. Theo. N. Ely, chief of motive power of the Pennsylvania Railroad; Mr. R. S. Hughes, president of the Rogers Locomotive Company; Mr. William Buchanan, chief of motive power of the New York Central and Hudson River Railroad; the Baldwin Locomotive Works; the Westinghouse Air Brake Company; Mr. M. N. Forney, M.E.; and Mr. Clement E. Stretton, C.E., of Leicester, England, for the valuable data and drawings they have kindly placed at his disposal.

THE ZONE SYSTEM IN HUNGARY.

THE zone system of fixing fares on the Hungarian railways, the inauguration of which was heralded by such a fanfare of trumpets, seems, even on the admissions of the administration of the lines, to have proved far from a complete success. It is true that the number of passengers carried increased from 9,056,000 in 1888 to 28,623,700 in 1892, but although the length of line open was also 10 per cent. greater, the receipts in the same period have only increased 40 per cent. As a matter of fact, passengers have dodged the tariffs in every way. Thus, they could be picked up at certain stopping places which were not regular stations, and the distance between such stopping place and the next station was not counted in fixing the tariff. Hence, when such a stopping place was near a station, many passengers, who under ordinary conditions would have boarded the train at the latter, walked on to the stopping place, and thus got carried free for some distance. This has now been altered, and the zone tariff for local traffic extends from one station to the next or next but one, regardless of distance. Other troubles arose in connection with the long distance zone, as passengers were permitted to break their journeys at intermediate stations, with the result that the ticket was often transferred to another individual, with consequent loss to the line. To stop this, passengers are now totally prohibited from breaking their journeys, and the tickets themselves are available only for twenty-four hours. As regards medium distance traffic of from sixteen to 140 miles, though rates on the adoption of the zone system were reduced some 40 per cent., the increase in the number of passengers has been only 22 per cent. in four years, and it is stated that the facilities for dodging the rates are so great that no amount of regulations can check it. In the case of local traffic, however, an increase of nearly 17½ millions of passengers was effected in the four years, or 730 per cent., the receipts being raised 200 per cent. in the same time. This increase, however, is largely due to the practice we have already referred to of passengers walking short distances to make journeys at local zone rates, when they ought really to come under medium distance tariffs.—Engineering.

CHANGE OF GEAR FOR BICYCLES.

IN the Bulletin de la Société d'Encouragement, we find some notes upon an ingenious change of gear that Mr. Archereau has applied to bicycles, as shown in Fig. 2. The principle of this device may be understood from an examination of Fig. 1.

The driving shaft, C, through an arm, D, carries along the toothed wheel, E, whose motion is checked by the movement of a roller, f, in a circular slide, H, eccentric with C; the roller engaging with the toothed wheel, G, keyed upon the socket, M, concentric with C; so that the velocity of M will be greater and greater according to the eccentricity of H. It will be seen from Fig. 2 that B is the axis of the crank hanger; k, the chain sprocket; and C, the socket, whose toothed wheel, D, actuates the three toothed wheels, E, which engage on the one hand with the rollers of the pinion, H, keyed upon the socket, M, of the wheel, and, on the other, with the ratchets, F, and the rollers, f, of the circular slide, H (eccentric with C), that move upon the path, U, whose train of wheels, V R O, permits of varying the eccentricity of H. The piece, P P, guided in the slides, L L, connected with H, serves as a brake.

In Fig. 3 are represented the wheels, E, whose teeth mesh with the internal teeth of the wheel, G. This latter revolves with so much the less velocity with respect to C in proportion as H is more eccentric.—La Locomotion Automobile.

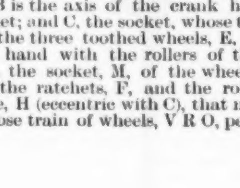


FIG. 1

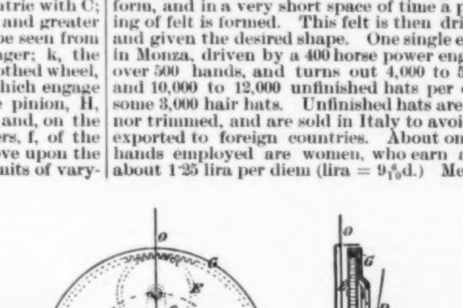


FIG. 3.

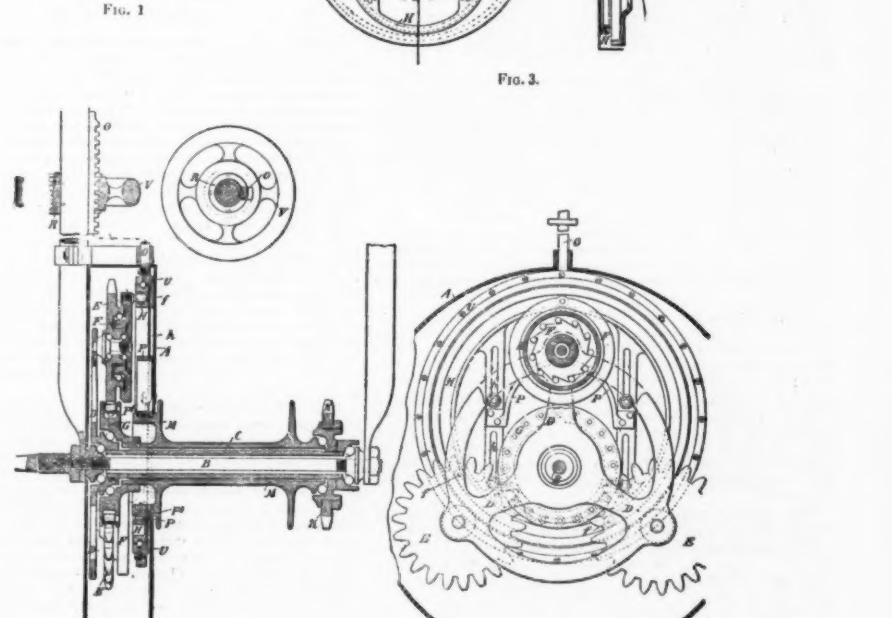


FIG. 2.

CONTINUOUS CHANGE OF SPEED FOR BICYCLES.

HAT MAKING IN ITALY.

HAT making is an important industry in Italy, both for felt and straw hats. Monza, near Milan, is the center of the felt hat industry, and there are many large establishments in that town. Felt hats are made of rabbits' wool and hair, but chiefly of the former material. The special machinery employed is both simple and ingenious, and is made in Monza. The fine dressed wool is blown with a strong, fine spray of steam and boiling water on to a heated revolving conical metal form, and in a very short space of time a paste or coating of felt is formed. This felt is then dried, removed, and given the desired shape. One single establishment in Monza, driven by a 400 horse power engine, employs over 500 hands, and turns out 4,000 to 5,000 finished and 10,000 to 12,000 unfinished hats per diem, besides some 3,000 hair hats. Unfinished hats are neither lined nor trimmed, and are sold in Italy to avoid duty when exported to foreign countries. About one-half of the hands employed are women, who earn at piecework about 1·25 lira per diem (lira = $9\frac{6}{10}$d.) Men earn about 2·50 lira per diem. The number of hours actual work is ten. About thirty per cent. of the production is exported. South America, France and Switzerland are the chief markets. There is also a trade with London for supplying British colonies. There are branch factories at Barcelona and at Buenos Ayres, which have been established to avoid payment of duties. The

value of felt hats exported is about £200,000 per annum. Straw hats and straw plaits for hats are chiefly made in Florence and the neighborhood. The plaits are sewn together, pressed and shaped in large establishments, while the plaits are made by women in the villages, who are paid so much a meter for plaiting, according to quality. The price paid for the plaits is very low, and not long since there was a strike among the plaiters. The industry has lost much of at least its relative former importance. The decline in the trade is attributed to the decreased demand for hats made of the finer qualities of straw, and to foreign competition in the production of coarse plaits. The best markets are in the tropics, and particularly in South America. The total value of the exports, including both hats and plaits, still exceeds £500,000 per annum.—Journal of the Society of Arts.

CHASSAGNE'S PHOTOGRAPHIC COLOR PROCESS.

It will be remembered that Chassagne's process has been described as based upon the property of selective color absorption superinduced by (1) treating the plate upon which the negative was taken with a special solution; and (2) treating the positive print with the same solution, the successive application of the blue, red, and green coloring solutions producing the natural color effect on the print. There is, however, no reference in the inventors' description to the treatment of the negative or the unexposed plate with any special solution, so that we must assume a misconception to have arisen.

The process appears to consist in treating a silver print or glass transparency with five specially prepared solutions, the composition of which we shall briefly describe.

1. Shadows Albumen.—One thousand grammes of distilled water are heated to from 37° to 40° C., divided into two equal parts, and poured into separate vessels, to the contents of one of which are added 200 grammes of pure blood albumen, the mixture being well stirred each half hour for three or four hours. The solution is to stand for twenty-four hours. To the other 500 grammes of water there is added 1 gramme each of the following chlorides: platinum, sodium, cobalt, palladium, ammonium, iron, chromium, gold, tin, barium, nickel, strontium, cadmium, mercury, and silver. This remarkable mixture is directed to stand, after "solution," for twenty-four hours in the shade. In another vessel ten grammes of hydrochlorate of cocaine are added to 125 grammes of water, the cocaine having been previously exposed to light for four or five minutes. This solution is also to stand in the shade for twenty-four hours.

To the solution of albumen are now added 5 grammes of sulphate of soda, 1 gramme of oxalic acid, and 25 centigrammes of mercuric chloride. One hundred grammes of this mixture are taken, and an egg and a "pinch" of hemoglobine are well stirred into it, and then returned to the albumen solution, to which the cocaine solution is also added. After thorough mixing, the solution containing the chlorides is slowly poured into the albumen solution, the combined mixture of albumen, chlorides, cocaine, soda, sulphate, mercury, etc., being allowed to stand in the shade for twenty-four hours. This is the "shadows" albumen.

2. Relief Albumen.—To half of the mixture just described add 1 gramme each of picric and chromic acids and 10 centigrammes of formic acid. Then in 125 grammes of distilled water dissolve 5 grammes of chloride of sodium, 1 gramme of chloride of platinum, and add 50 grammes of fresh caseine. Add this to the mixture containing the picric and chromic acids and allow to rest 24 hours.

3. Blue Pigment.—To 10 centiliters of shadows albumen are added 1,000 grammes of distilled water in which 1 gramme of sodium chloride is dissolved; to 100 grammes of this solution are added 5 grammes of carmine of indigo and 5 grammes oxalic acid. The two solutions are then mixed.

4. Green Pigment.—To 1,000 grammes of distilled water in which 1 gramme of sodium has been dissolved, 5 centiliters of shadows albumen and 5 c. c. of relief albumen are added. In two flasks are poured 2 portions of this solution, equaling 50 grammes respectively. In one a gramme each of the chlorides of nickel, chromium and copper, 1 gramme of sulphate of copper, and 1 gramme of nitrate of copper are dissolved. To the other 50 grammes of solution, 1 gramme of "carmine of indigo" and 1 gramme picric acid are added; mix by adding the chlorides solution to the indigo solution and add to the remaining 900 grammes of solution. Agitate thoroughly several times and leave to rest for 24 hours.

5. Red Pigment.—To 1,000 grammes of distilled water, in which 1 gramme of sodium chloride has been dissolved, add 10 centiliters of relief albumen. Take two separate quantities of 50 grammes each of this solution; to one add 1 gramme of sulphide of mercury (cinnabar), 1 gramme chloride of iron, 1 gramme sulphate of iron, 1 gramme acetate of uranium; and to the other 5 grammes of sulphocyanide of ammonium. Mix the two solutions, add 30 grammes of fresh caseine, and then return the mixture to the 900 grammes of relief albumen solution. Well mix, and allow to stand for 24 hours.

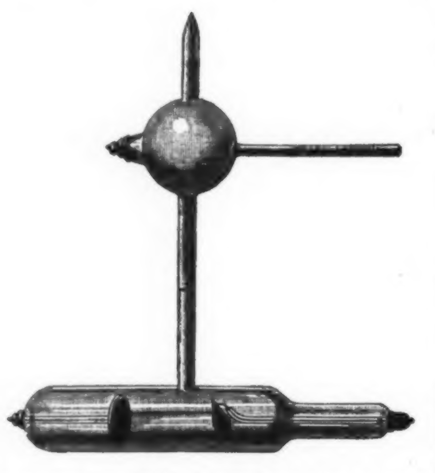
The five liquids are to rest for 8 days, although a period of 3 or 4 months is recommended in preference.

The method of using these five solutions is briefly as follows: Take (1) 10 centiliters of shadows albumen, and add to 1,000 grammes of distilled water, in which 1 gramme of sodium chloride has been dissolved, and (2) 10 grammes of relief albumen in 1,000 grammes of distilled water, in which 1 gramme of sodium chloride has been dissolved. Apply the shadows albumen to the print, presumably by immersion, and then the relief albumen. Next brush on blue pigment, followed by shadows albumen; green pigment diluted with shadows and relief albumen; relief albumen; red pigment diluted with relief albumen; and finally with shadows albumen.

The foregoing is substantially the inventor's description of the Chassagne "selective color absorption" process—a process the rationale of which, to say the least of it, is not obvious. Frankly, we are disposed to regard this very extraordinary method of coloring photographs here outlined as either a hotch-potch of empiricism and mere chemical guesswork, or a strangely complicated and involved description of what, judging by the results that have been shown, is possibly a promising process for producing photographs in colors. For the present, however, we reserve further comment, and will await with interest the results of any practical experiments on the lines laid down by the inventors.—The British Journal of Photography.

A NEW ROENTGEN LAMP.

Siemens & Halske have recently produced a new lamp for the production of Roentgen rays, in which the vacuum can be easily regulated to produce the maximum effect. The air pressure is reduced by taking advantage of the circumstance that when air, rendered luminous by the passage of electricity, comes in contact with the vapors of phosphorus, iodine or similar substances, it forms solid bodies; the vacuum is reduced by warming the bulb in the well-known way. From the illustration, for which, with the particulars, we are indebted to the Electrical Review, it may be seen that a supplementary bulb is joined on to a cylindrical focus tube by a glass connecting tube. In the bulb is an additional anode, and opposite this anode is a small adjutage tube whose walls are covered with the air absorbing material, for example, phosphorus. If, when the lamp is excited and examined by a screen, the fluorescence is weak, and the blue cone from the cathode shows that the vacuum is too low, the positive pole of the induction coil is connected to the auxiliary anode in the bulb and the discharge continued till the vacuum is sufficiently reduced. The special improvement in this lamp is evidently intended to provide the means of reducing the air pressure when it is too high, but all experience with X ray tubes seems to demand rather some convenient means of increasing the air pressure, which is soon enough reduced by the cathode discharge in the ordinary working of the tube. Heating the tube may stave off the difficulty for a time, but after long use this device is useless and the tube has finally to be abandoned. The Siemens-Halske tube,



however, appears to be very efficient while it works. With a six inch coil it is stated that it will show the skeleton of the hand through a brass plate two mm. thick.

DOGS IN WAR.

In the present day the British army seems the only one in which dogs are not trained either as spies, messengers, or to help the wounded. The Germans, French, Austrians, Russians, and Italians have all found them to be worth the trouble. The Germans have devoted themselves chiefly to the training of dogs for carrying messages to and from outposts and pickets to the main bodies of troops. For this purpose they find pointers are the best; but Scotch sheep dogs and short haired sporting dogs are also much liked, as are also the clever little Pomeranians, which learn very quickly, and are very strong and swift. In the German army the best trainers are the men of the Jager regiments, and a special officer and a special body of men are told off to look after the dogs. They are taught to march without frisking about, to avoid barking, but, with their wonderfully quick ear, to warn if strangers are near, by pointing, or by a low growl. They are trained to carry messages up to two miles and a half by known roads, and beyond that distance to find their own way across country. To men in the same uniform they are taught to be obedient.

In the Russian army a kind of big St. Bernard mastiff is used, also wolf and sheep dogs. These, equipped with a flask containing brandy or soup, and a packet of bandages hung round their necks, are taught to find out the wounded lying among bushes or uneven ground, and to offer them restoratives, standing meanwhile with their forefeet planted, and barking, to attract attention. They are even harnessed to little hand carts, such as we see them use in Belgian and German towns, and can drag two wounded men. The French, in their wars in Tunis and Algiers, have used dogs, also the Russians in their last Turkish war. In Austria they have been employed to discover ambuscades. The Dutch in Acheen found them most useful in preventing solitary sentries in thick jungle outposts being surprised by stealthy natives. The Italian sentries in the Alps are always accompanied by dogs.—The United Service Magazine.

The new United States Mint, at Philadelphia, is to be commenced shortly, says the Times, of that city. The new building will cover the block bounded by Sixteenth and Seventeenth Streets and Spring Garden and Buttonwood Streets, and the estimated cost is $1,652,000. It will be in the form of a hollow square, with a frontage of 316 feet. The work of excavating the foundation is already in progress, under Allen B. Rorke, the contractor.

THE POSITION OF THE TARSIIDS AND RELATIONSHIP TO THE PHYLOGENY OF MAN.*

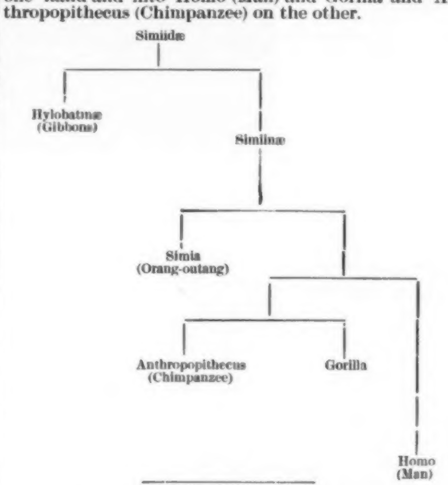
By Theodore Gill.

Prof. Gill maintains that man resembles the chimpanzee and the gorilla more than the orang outang, the mere external resemblances being illusory. Man and the Primates first named have descended from a common ancestor. The changes in physical structure are due to abandonment of the arboreal habitat. The long arms, being no longer used for tree climbing, become abbreviated. Children, however, still show this ancestral characteristic, their arms being proportionately longer than those of adults. The teeth in man diminish in size and come closer together, thus closing up the gaps which exist in the jaws of apes. The large muscles which actuate the jaw, being no longer exercised in grinding the branches of trees, diminish, and the bony ridges to which they are attached, being now unnecessary, diminish also, till we have the rounded face of man instead of the rough and rugged visage of apes.

Prof. Gill exhibited two tables of descent, from which he supposes the Primates to have divided first into Lemuroids on the one hand, and Tarsioids (Tarsiers) or new world monkeys on the one hand and Anthropoids or old world monkeys and apes on the other.

The Anthropoids in turn divided into Simiidæ (Apes) and Cercopithecidæ (Tailed Monkeys).

The second diagram, as given below, shows the division of Simiidæ into Simia (Orang-outang) on the one hand and into Homo (Man) and Gorilla and Anthropopithecus (Chimpanzee) on the other.



ON RECENT BORINGS IN CORAL REEFS.*

By Alexander Agassiz.

Prof. Agassiz referred to the theory of Darwin that coral reefs have been formed by subsidence, the coral polyp building the reef as the submerged land subsides. This theory, however, would require a thickness of 2,000 ft.

In fact, his observations show that the great atoll on the Yucatan bank is only 32 fathoms deep; others are 18 to 20 fathoms.

Duffie examined reefs on the Solomon Islands, and found them to be 125 to 130 ft. deep.

Subsequently, borings were made in the elevated reef of Florida, which gave it a depth of 60 ft. As the surface has been denuded, however, 60 ft. more may be allowed.

Along the coast of Cuba the reef is 145 ft. deep.

Prof. Agassiz attempted to measure the thickness of the great Australian coral reef, which is 1,500 miles long and 50 to 75 miles wide, but he failed to get accurate results. His estimate of the thickness of this reef, however, is 25 to 30 fathoms.

It seems, therefore, that the old theory of formation of these reefs by subsidence must be abandoned.

VARIATION OF LATITUDE AND CONSTANT OF ABERRATION FROM OBSERVATIONS AT COLUMBIA UNIVERSITY.*

By J. K. Rees, H. Jacoby and H. S. Davis.

These observations extended from May 9, 1893, till June 14, 1894, and were divided into groups of from 30 to 100. They were corrected for evaporation, this correction being 20·462", a close approximation to Struve's value. They confirm Chandler's period of about 427 days.

The latitude of the observatory of Columbia University is accurately determined as 40° 48' 27·195".

ON A RING PENDULUM FOR ABSOLUTE DETERMINATIONS OF GRAVITY.*

By T. C. Mendenhall and A. S. Kimball.

It has long been possible to determine relative differences in gravity with extreme accuracy. The absolute determination of gravity was more difficult. At the suggestion of Prof. Kimball, recourse was had to a ring vibrating in its own plane, instead of using an ordinary pendulum. By varying the relative diameters of the inside and outside of the ring, results are obtained corresponding with the vibration of pendulums of any length from infinity to that of the diameter of the outer circle.

The following formula gives the rule for computing the length of pendulum corresponding with a given disk of metal:

$$l = \frac{R^2 + 3R^2}{2r_2}$$

in which l is the length of the pendulum, R is radius

* Abstract of a paper read before the National Academy of Sciences, at Washington, April 21, 1897.

of the large circle and r that of the small one. The best results are obtained by using a disk in which the inner circle is about one-half the diameter of the larger one. In this way a degree of accuracy is gained correct within one part in 10,000.

THE SYNCHRONOGRAPH.

A NEW METHOD OF RAPIDLY TRANSMITTING INTELLIGENCE BY THE ALTERNATING CURRENT.*

By ALBERT CUSHING CREHORE and GEORGE OWEN SQUIER.

IN a general view of the technical history of the art of telegraphy, statistics show that at the present time, more than fifty years since the introduction of the telegraph, nine-tenths of the telegraph business of the world is transmitted by hand, in substantially the same manner as then. From an electrical point of view one naturally asks why it is that during this period, which represents more electrical progress than all time previous, the rapid transmission of intelligence has not made more advance.

It is to experiments upon a new electrical system of rapid intelligence transmission and its possibilities that your attention and consideration are invited. It is not intended to enter into a discussion here of the physical causes which have limited the speed and efficiency of the telegraph, but to acknowledge the great work of Wheatstone, Hughes, Edison, Delany and others, who have brought rapid telegraphy to its present state of efficiency, and proceed to an explanation of the principles involved in the new system, and an account of the experiments already carried out in developing it. These experiments were conducted at the Electrical Laboratory of the United States Artillery School, Fort Monroe, Va., where the land telegraph and telephone lines were available for the actual trials described.

PRINCIPLES OF THE TRANSMITTER.

It is difficult to treat the subject of transmitters apart from their receivers, as any particular transmitter should be considered in connection with the limitations of its receiving instrument. If we could have a receiver sensitive enough to make a distinct and permanent record of every change in current transmitted over the line, provided the line were so situated as to be free from the disturbing influences induced by external causes, it would be ideal; and the discussion of transmitters would be simplified by reducing the elements to the line and transmitting instrument alone. The qualities of receiving instruments include two principal elements. They all require a certain amount of energy to operate them, and in addition, most of them have inertia in the moving parts. A distinct advance is made, other things being equal, in the receiver which dispenses entirely with the inertia of moving parts. This is accomplished by electrolysis in the chemical receiver of Bain, which has recently reached great perfection in the hands of Mr. Delany. It is also accomplished in the polarizing receiver which was used in experiments described later.

Transmitters for sending intelligence over electrical circuits are, in every case, instruments which operate to change the strength of the current employed in the line. This includes the telephone, in which the current is a succession of waves differing not only in the frequency with which they occur, corresponding to the pitch of the tone, and in the amplitude corresponding to the loudness, but also as to the shape of the waves corresponding to the timbre or quality. The human ear is such a delicate and wonderfully constructed receiver that it readily translates this complex wave into intelligence. If a physical instrument could be found which would write out in visible form the exact shape of these telephone waves received, the eye might also be educated to translate them. A perfectly trained eye could detect the difference between the same words spoken by different individuals as the ear now does. Even though the waves might be accurately reproduced, the simpler the waves, the less the difficulty of translating them.

The inherent distinction between telephony and telegraphy is mainly that, whereas the telephone utilizes both the frequency of the waves and their form, telegraphy relies entirely upon the duration, number and order of arrangement of these waves, and not their form. The art of telegraphy is practically limited in this respect to three elements, or their combinations, namely, varying the duration of the waves or pulses, the direction of them, their order of arrangement, or the different combinations of these. Considering these elements separately, the first one, using waves of different duration alone for each character upon the line, is not at present used. The last method, a combination of variable duration and order of arrangement of waves, comprises the system of Morse and others so universally used, and includes the more rapid system of machine telegraphy due to Wheatstone.

There are reasons why any system using waves of different duration is not as simple as one which uses waves of equal duration, when any arrangement of make-and-break transmitter, using a constant source of electromotive force, is employed. Some of the chief of these are found in the electrical properties of the line carrying the currents. The difficulties become apparent only when it is attempted to send these waves at a very rapid rate, which is desirable in machine telegraphy. The current requires time to become established at the receiving end of the line after the electromotive force is introduced at the sending end. The current wave which is sent over the line is a function of the time during which the electromotive force remains applied at the transmitter. There is evidently a practical limit to the shortness of the time which the electromotive force must remain applied, determined by the smallest wave which the receiver is capable of recording.

Suppose on the other hand that the electromotive force has acted long enough for the current at the receiver to reach its steady value, and then the circuit is suddenly broken at the transmitter. A time will elapse before the current in the receiver is reduced to zero. This case is not as simple as the former, because the manner in which the break is made must be considered. A slow break is different from a rapid one, when there is any arc, that is, a spark formed. The whole line has been charged to the limit of the electromotive force used, and must become sufficiently discharged before the next wave can be received. This produces the effect commonly known as "tailing," which means that a signal becomes so drawn out at the receiver that it interferes with the following signal.

If waves of equal duration are used, evidently more of them may be received in a given time than of any other combination of waves, for the shortest wave may be used which will operate the receiver. With this plan, the effect of "tailing" is reduced. The use of equal waves is adopted by Mr. Delany, who also indicates by the chemical receiver the directions, whether positive or negative, of these equal waves.

The alternating current is at present successfully employed for transmitting considerable amounts of power over long distances, and the whole system is periodically subjected to a regular and uniform succession of waves rising gradually from zero to a maximum, and then gradually decreasing, reversing and increasing to a negative maximum. Recognizing these facts, it seemed probable that it would constitute a good means for the rapid transmission of intelligence, if the characters of a telegraphic code could be impressed upon such a current without seriously affecting its regular operation. It is to the consideration of a system of rapid transmission of intelligence by the use of the alternating current that we invite your attention.

Let the sine curve, Fig. 1, represent a regular succession of simple harmonic current waves given to the line by an alternating current generator. If the current passes through a key which may be opened or closed at pleasure, then, provided the key previously closed is opened at a time corresponding to the point, P, of the wave upon the horizontal axis, it is known that the current which was zero at the instant the key was opened will remain zero thereafter, in circuits which have resistance and inductance alone. Again, if the key could be closed exactly at a time corresponding to the point, Q, on the curve also upon the axis, the current will resume its flow undisturbed according to the sine curve. The true current obtained by opening the key at P and closing it at Q is shown in Fig. 2, where the current remains zero between these two points. If the key had been closed at any other point than Q, as at R, the current would not have resumed its flow according to the simple sine wave; but, it can be shown, would follow the heavy curve of Fig. 3, and give a succession of waves alternately smaller and larger than the normal sine wave until after a very few alternations, when it practically coincides with the sine wave. In like manner if the key is opened at some other point than P, when therefore the current is not zero, a spark may be observed at the break, and it requires time for the current to fall to zero.

Let us consider the advantages of thus operating upon an alternating current. It is evident that the advantages above mentioned of using a system subjected to a perfectly regular alternating electromotive force, and capable if necessary of transmitting considerable amounts of power, is by this method made available. In addition, no spark is made in a transmitter adjusted to break the circuit at the exact times indicated by the curve above, when the current is naturally zero. This makes it possible, if it is found desirable, to use comparatively large electromotive forces and currents on the line; for, no matter what the maximum value of the current, it is made and broken by this plan with no sparking. It is also possible to employ waves of high frequency upon the line, the upper limit obtainable from an alternator being probably much higher than can be transmitted over the line.

If a receiver were used which could reproduce an exact trace of the actual waves sent over the line, it might resemble such a combination as that represented by the heavy curve in Fig. 4. The sine wave continues uninterrupted to the point, P, when the key is opened, and it is held open for one complete wave length, P Q, when it is again closed for a wave length, Q R; then opened for one half a wave length, R S; closed for a wave length, S T; opened for a wave length, T U; closed for half a wave length, U V; opened for half a wave length, V W, and finally closed. By this plan it is possible to use the ordinary Continental code in telegraphy, a dash being indicated when two successive waves, a positive and a negative one, are omitted by keeping the key open, and a dot meaning where a single half wave is omitted. The space between parts of a letter, as between the dash and dot of the letter "n," is indicated by the presence of one-half a wave length, and the space between letters, as between "t" and "e" in the word "ten," by the presence of two half waves, while the space between words may be represented by the presence of three half waves, and between sentences of four half waves or more. The above is a single example, of which there are many, of a method by which the usefulness of so operating upon an alternating current is made apparent, because it shows how these signals may be interpreted by a fixed code. It need not be said that there are other ways easily devised of interpreting the possible combinations of waves which may be sent in accordance with any code, and it is not our present object to present a method which is deemed superior to others, but merely to show that the above plan becomes operative.

A consideration of the time required to send the word "ten" by the above plan shows that it corresponds to the time of eleven half waves of current. If we suppose that the frequency is an ordinary one used in alternating current work, viz., 140 complete waves per second, the time required to send the word "ten" is 0·0394 of a second, or, by allowing three additional half waves for the space between the words, the word "ten" would be sent just 1,200 times in one minute. There is no difficulty in using over some lines a frequency four times as great as that ordinarily used, namely, as high as 560 or even 600 periods per second. This would correspond to speeds of 4,800 and 5,143 times sending the word "ten" per minute. The limit in each instance is only determined by the particular line used.

Hitherto it has not been pointed out how it is possible to manipulate a key at the high speed mentioned so as to open and close the circuit hundreds of times per second as desired at the exact instants when the current is naturally zero. Evidently the proper place to manipulate such a current controller, where the circuit must be made and broken at distinct points of phase, is at the generator itself, or in connection with any motor running synchronously therewith.

It will be sufficient for purposes of illustration to show by a special example how any single half wave may thus be controlled at the generator; for obviously any word or sentence may be formed by a repetition of this operation.

In Fig. 5, S represents the shaft of an ordinary 10 pole alternating current generator which drives through the gears, M and N, the wheel, W. The circumference of this wheel is one continuous conductor presenting a smooth surface for brushes to bear upon. If the periphery of the wheel is divided, for example, into 40 equal parts, and it is geared to run at one-fourth the speed of the armature, each division thereof corresponds to one semicycle of the electromotive force produced by the generator. Upon the wheel, W, bear two brushes, A and B, carried by a brush holder which is capable of adjustment. These two brushes are connected in series with the line, so that the current which passes in at one brush is conducted through the wheel to the other brush, and thence to the line. The current used may be obtained from the generator, the shaft of which is represented at S, either before or after it has passed through any number of transformers, since it is the frequency alone with which we are concerned.

The line current is brought to the wheel, W, to be synchronously operated upon. If both brushes remain continually in contact with the wheel, the current transmitted would have the regular sine form represented in Fig. 1, and for each revolution of the wheel there would be 40 semi-waves or 20 complete waves transmitted. If one-fortieth of the circumference of the wheel is covered by paper or other insulating material, as indicated at I, Fig. 5, and the brush, A, ad-

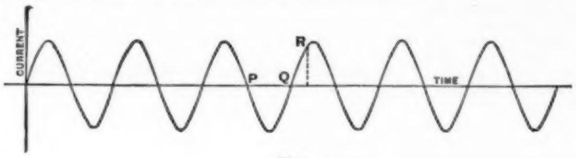


FIG. 1.

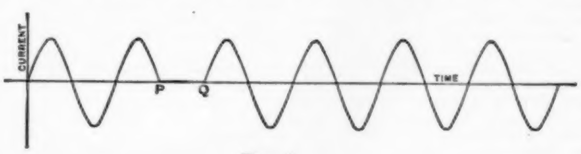


FIG. 2.

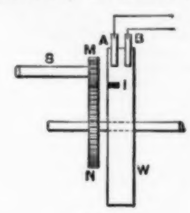


FIG. 5.

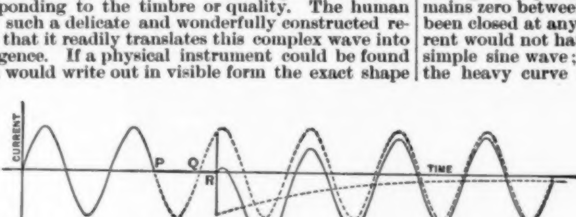


FIG. 3.

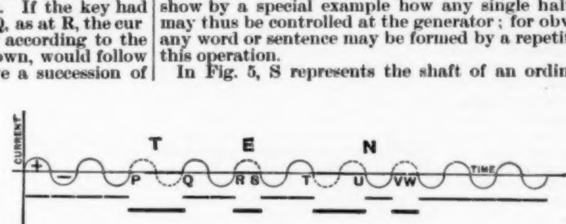


FIG. 4.

*A paper presented at the 115th meeting of the American Institute of Electrical Engineers, New York and Chicago, April 21, 1897.

justed to ride on to and off from this insulation just as the current is changing from one semicycle to the next, that is, changing sign, while the brush, B, is in continuous engagement with the wheel, the semicycle represented by the section covered will be suppressed, and without any sparking, even if the potential used is high. In practice, the brush, A, is easily adjusted to this point by moving it slightly, backward or forward, around the circumference of the wheel until the sparking ceases. This adjustment once made, the brush is fixed in position and so remains. In each succeeding revolution of the wheel, this cycle of operations is exactly repeated, and the current sent over the line would resemble that shown in Fig. 2, having every fortieth semicycle omitted. It is only necessary to cover other similar sections of the circumference of the wheel in a predetermined order according to a code, to transmit intelligence over the line. The above illustration of the operation of a transmitter on this principle is given for simplicity only, and is evidently far from a practical form of transmitter.

The wheel, W, in the above example, may have different speeds with respect to the generator shaft, the essential condition being that its circumference shall contain some integer number of a unit, which is the arc upon the circumference of the wheel if geared to the armature, that a point fixed with respect to the field would describe upon it during one semi-period of the current. This wheel therefore might be connected to any shaft which runs in synchronism with that of the generator, as for instance that of a synchronous motor, if the power was obtained from a distance.

Instead of using insulating papers situated upon a single circumference of the wheel, two or more similar lines may be used either upon different circumferences of the same wheel or upon different wheels, and separate brushes ride upon the different circumferences. The same frequencies of current may be employed to operate all lines of brushes, or currents having different frequencies may be employed upon the separate circuits, all of which use the same line for transmission. These arrangements make it possible either to send different messages simultaneously over the same line, employing a single cycle as the unit, or to send a message employing different frequencies to represent the different characters of a code, or many combinations of these.

The employment of alternating waves of different frequencies upon the same line by the method shown does not have the same objections which exist when a constant electromotive force is used. Since the circuit is by this system always interrupted when the current is naturally zero, the frequency employed is within certain limits a matter of indifference, as the line is in the same condition whether a long or short wave is used.

It is seen that by this simple method of operation upon the alternating current, according to the above principles, there is complete control of the individual semiwaves of the current, which may be changing direction thousands of times in a second, far beyond the range of possible manipulation by hand. In other words, it is easy to obtain a record of any pre-selected order or succession of semi-waves desired. It is evident that it is as important to be able to control the semiwaves retained as it is those suppressed, since they are of equal value in interpretation. Furthermore, there is great utility in being able to control each single semiwave of the current, for this permits the maximum speed of transmission of signals with a given frequency.

A transmitter which operates upon the current at intervals comparable with the duration of a semiwave, but which does not act in synchronism with the current, would necessarily make and break the circuit at times when the current is not naturally zero. If this were done, there would not only be sparking, but in addition, the current would be interfered with in such a manner as to make it probable that the record received could not be interpreted; for the current at each make would follow such a curve as that shown in Fig. 3.

PRINCIPLES OF RECEIVERS.

As used throughout this paper, the term "receiver" will be understood to mean that mechanism which uses the energy transmitted over an electric circuit, and transforms it so as to make a permanent record which may be translated into intelligence. The term receiver is here restricted to mean instruments which make a permanent record, since this is a necessary condition for the rapid transmission of intelligence, with which we are at present concerned. All receivers require a certain amount of power to operate them, and the power required affords one basis for their classification.

Another method divides receivers into two classes—those which have inertia in the moving parts and those which have none. There is no fundamental reason why any one of these general classes should contain all of the most rapid receivers. Any of the above classes might include receivers which are very rapid. If, for instance, a receiver has inertia in the moving parts, for rapidity the amount of inertia should be small, and its natural period high, or a large moment of energy would be required to operate it. If a receiver has no inertia in the recording mechanism, then the possible rapidity is limited by the power supplied.

In deciding upon the relative merits of receivers from the point of view of rapidity, the cost of the power required offers no reason why considerable amounts of power should not be transmitted over certain land lines for purposes of telegraphy. Using a receiver which possesses much inertia in its moving parts, it does not follow that even though considerable energy reaches the receiver over the line, it will be rapid in its action.

The Wheatstone receiver may be taken as representative of a type of receivers possessing inertia in the moving parts, which has come into successful operation. The record is made in this instrument by a small wheel which vibrates back and forth between an ink surface and the recording tape. The energy which is essential is that required to move this little wheel and the parts connected with it back and forth. Although considerable energy may possibly be sent over the line and be expended in the instrument, it seems impossible to concentrate more than a certain part of it upon the moving mechanism. This suggests two methods of improving the speed of the system; either to increase the power received by the moving parts or diminish this moment of inertia. One factor which limits the Wheatstone type of receiver is that the moving parts are required to do the work of making the record. This is not a necessity, since light may be employed as the agent to make the record under the control of the moving parts, as is evidently accomplished in a form of galvanometer having a very minute needle with mirror attached, the slightest motion of which is greatly magnified by the reflected beam of light.

As a type of instrument having no inertia in the recording mechanism may be mentioned the various forms of chemical receivers acting by electrolysis. This type of receivers possesses many advantages, perhaps chief among which is the fact that a large part of the energy received is brought directly to bear upon making the record. Another feature is the simplicity of the essential mechanism involved, as no intermediate steps are employed after the impulse is received from the line before the record is made. These qualities alone imply rapidity, and this receiver is one of the most rapid known. The limit of rapidity with this receiver is the power received from the line. If the potential between the terminals of the receiver is increased, the time required to make a given record is correspondingly reduced. The use of the alternating current permits of greater potentials being realized in the receiver with less disturbing influence from the line than would be the case if a constant direct electromotive force was employed.

A new type of receiver having no inertia in the recording mechanism was used in developing the transmitter described in these experiments. This instrument has already proved of value as a chronograph for the measurement of minute intervals of time, and for the study of any kind of variable electric currents. Although its application as a practical telegraph receiver is not at present advocated, yet the realization of a massless receiver upon different lines merits description. This receiver is based upon Faraday's discovery of a direct relation between light and electricity.

This discovery was, that if a beam of polarized light is passed through some substance in the direction of the lines of magnetization within that substance, there is a rotation of the plane of polarization in a direction which is the same as the direction of the current required to produce such a magnetic field. The direction of rotation is unaltered, therefore, whether the light beam advances in the same or in the opposite direction to the magnetization, so that a beam reflected back and forth through the substance several times has its rotation increased by equal amounts each time. If the direction of the ray of light is at right angles to the lines of magnetization, there is no rotation produced. The amount of this rotation has been investigated by Verdet, who announced laws by which it may be expressed. They are summed up in the following statement:

"The rotation of the plane of polarization for monochromatic light is in any given substance proportional to the difference in magnetic potential between the points of entrance and emergence of the ray;" that is, it is equal to a constant times this difference of potential and is expressed by the formula

$$\theta = v\,V,$$

where θ = angle of rotation, V = difference in magnetic potential, and v for a given wave length is constant in any one substance and is known as Verdet's constant.

The following example will make more evident the application of Faraday's discovery to this receiver. Admit a beam of ordinary light through a small aperture into a dark room and let it fall upon a white screen. Suppose that the aperture which admits the beam is provided with a shutter which may be opened or closed at will. We have in this simple arrangement all the essentials of a transmitter and receiver of intelligence. A person opening and closing the shutter might communicate with a second person observing the screen, which would become light and dark at intervals in accordance with a prearranged code. Substitute for the first person in direct control of the shutter an electromagnetic device, operated from any desired distance through an electric circuit, and the effect upon the screen is the same as before. For rapid transmission it would be necessary to substitute a mechanical transmitter which would operate faster than a person can send by hand. There would be no particular difficulty in thus moving the shutter more rapidly than any observer could read from the screen. It then becomes necessary to make a permanent record, which may be accomplished by substituting for the screen a self-recording surface having a relative motion across the beam. This is afforded by using any surface sufficiently sensitive to light, many varieties of which are available. In fact, a surface is available which is so sensitive that it will record much faster than the material shutter can be moved back and forth so as to open and close the aperture.

The next step in increasing the speed, provided the limits of the transmitter have not already been reached, is to secure a more rapid shutter. It was with this object in view to obtain a massless shutter that Faraday's discovery is used. Instead of passing the light directly through the aperture, it is first passed through a Nicol prism in order to obtain a beam of plane polarized light, or it may be polarized in any other suitable manner. Suppose that a second Nicol prism like the first is placed in the path of the polarized beam. If the second prism known as the "analyzer" is turned so that its plane is perpendicular to that of the first prism known as the "polarizer," all the vibrations not sorted out by the polarizer will be by the analyzer. In this position, when the planes are perpendicular to each other, the prisms are said to be "crossed," and an observer looking through the analyzer finds the light totally extinguished as though a shutter interrupted the beam. By turning the analyzer ever so little from the crossed position, light passes through it, and its intensity increases until the planes of the prisms are parallel, and if one of the prisms is rotated, there will be darkness twice every revolution. In order to accomplish the same end that is obtained by rotating the analyzer without actually doing so, the following plan is adopted. Between the polarizer and the analyzer is placed a transparent medium which can rotate the plane of polarization of the light, subject to the control of an electric current, without moving any material thing. The medium used in this receiver is liquid carbon bisulphide contained in a glass tube with plane glass ends. There are many other substances which will answer the purpose, some better than others. This was selected because it is very clear and colorless,

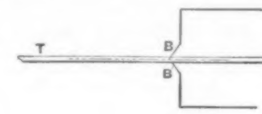


FIG. 6.

and possesses the necessary rotatory property to a considerable extent. It only possesses this property, however, when situated in a magnetic field of force, and the rotatory power is proportional to the intensity of the magnetic field. To produce a magnetic field in the carbon bisulphide, a coil of wire in series with the line from the transmitter is wound around the glass tube. When the current ceases, the carbon bisulphide instantly loses its rotatory power. The operation is as follows: First the polarizer and analyzer are permanently set in the crossed position, so that no light emerges from the analyzer. A current is sent through the coil around the tube. The plane of polarization is immediately rotated. This is equivalent to rotating the polarizer through a certain angle, and hence light now emerges from the analyzer. Break the current, the medium loses its rotatory power, and there is again complete darkness. This arrangement makes an effectual shutter for the beam without moving any mass of matter.

This illustrates how Faraday's discovery may be utilized to replace the electromagnetic shutter in the above example by a massless shutter, which enables the current waves sent over the line to be recorded upon the sensitive surface without moving any material thing. An advantage of this receiver is that the speed is not limited by the receiver, but only by the natural properties of the line or of the transmitter. Used in connection with the transmitter already described, the real limit is found to be in the line itself.

An analysis of this receiver shows that the energy received over the line is not used directly in making the record, but the agent which makes the record is the beam of light which derives its energy from a local source. The energy received from the line merely controls this local energy, which may have considerable power behind it. This controlling phenomenon is one of the few known cases where electricity acts directly upon light. The mechanism by which this action is effected is not at present known, and any experimental evidence upon it would increase our knowledge of the connection between ether and ordinary matter, as well as the constitution of matter itself. The use of this direct influence of electricity on light makes the speed of transmission through the receiver comparable with the velocities of these agents.

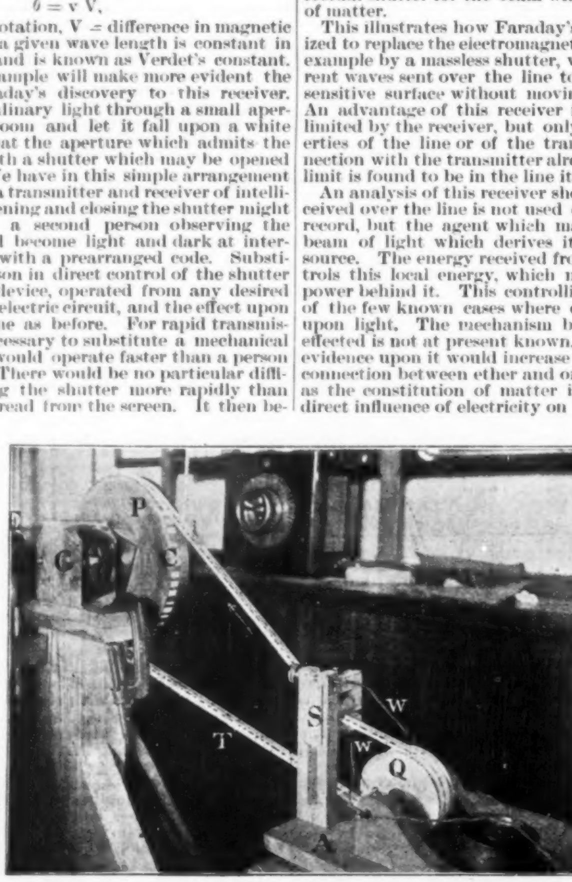


FIG. 7.

DESCRIPTION OF THE TRANSMITTER USED.

In these experiments, the operation upon the alternating current, according to the principles already stated, was accomplished by means of a prepared perforated paper tape, which was caused to move by the generator itself. A view of this tape, showing a method of operating upon the current, is given in Fig. 7.

The line current is brought through the wires, W W,

to two brushes, B B', not shown in the view, held by the adjustable support, S. The plan of the brushes is shown in Fig. 6. One brush, B, bears upon the tape from above, and the other brush, B', bears from below immediately opposite the other brush, so that they will meet through the perforations in the transmitting tape, T. When the brushes meet through the perforations in the tape, the line circuit is closed, and when paper passes between them, separating the brushes, the line circuit is broken.

It is so arranged that the brushes pass off from and on to the paper, thus making and breaking the circuit, at the instant corresponding to the points in the current wave, Fig. 1, when the alternating current is naturally zero. The tape, T, passes over a wheel, P, geared to the generator shaft, so that for one revolution of the armature the tape advances a fixed distance. If the generator has ten poles, this fixed distance on the tape corresponds to five complete waves or ten alternations or semicycles of the generator current. One-tenth of this fixed distance corresponds to one alternation or semicycle of the current, and may be taken as the unit of distance in perforating the tape. If, therefore, a hole is made in the tape equal in length to this unit, and the brushes, B and B', happen to pass off from the paper so as to meet through the hole at the instant the current is naturally zero, then they will pass on to the paper again, breaking the circuit at the next following instant when the current is also naturally zero, since the length of the hole corresponds to one semicycle of the current.

Suppose that a succession of these unit holes is made,

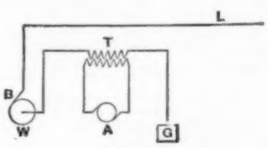


FIG. 8.

the tape between the holes being also of unit length, then the circuit will be made and broken as by the first hole at the points of zero current. In practice it would probably not happen that the brushes were at first so situated as to pass off from and on to the paper at the instant the current is zero. In this case a succession of sparks appears, one each time the brushes pass on to the tape, and by moving the brushes along the tape it will be observed that this spark either increases or decreases in intensity, according to the direction moved; but at regular intervals, equal to the unit mentioned above, it disappears. This position of the brushes for no sparking is easily found by trial, and once obtained, remains fixed. By this simple practical operation, which experience shows requires but a moment to accomplish, the essential condition of synchronously operating upon the current in the manner described is secured. The brushes once adjusted always so remain, and, since there is no sparking, it is possible to use high electromotive forces upon the line without injurious effect upon the brushes and tape. It is also plain that this method of operating upon the current is not affected by the speed of the generator, since the transmitting device is always in synchronism with the generator, whatever the speed. The speed of the generator, and, consequently, the rate of sending, as far as the transmitter is concerned, can be varied at pleasure between wide limits, without any effect upon the synchronous operation described.

An example, giving the data from an early experiment, will illustrate how this is accomplished. The generator was a Fort Wayne 10 pole alternator, giving

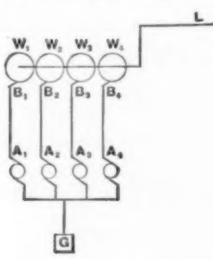


FIG. 9.

a potential at its terminals of 1,000 volts. This was transformed to about 300 volts, being convenient to handle, and sufficiently high for the purpose. The end of the shaft, E, Fig. 7, of the generator carries a small pinion, which engages the gearing, G, and revolves the wheel, P, once in every 18·4 revolutions of the armature. This makes the $\frac{1}{184}$ part of the circumference of the wheel, P, correspond to one semi-cycle of the current. The circumference of the wheel was about 100 cm., and the length of a unit, therefore, $\frac{1}{184}$ of this, or 0·54 cm.

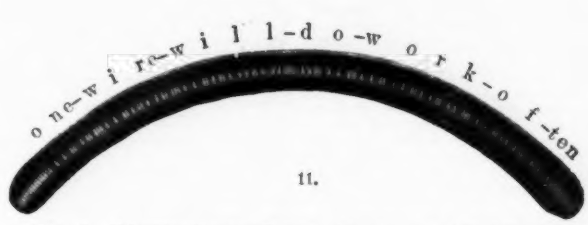
For convenience, a tape made of ordinary paper had its two ends joined so as to make a continuous belt, which made it possible to use it repeatedly. The tape passed from the large wheel, P, to the loose pulley, Q, mounted upon a baseboard, A, and under the guiding pulley attached to the support, S, which controlled the tape, immediately before passing the brushes, B B'.

In preparing the tape, the Continental code was employed as described, the omission of two half-waves meaning a dash, and one half-wave a dot. Having obtained the length of a unit on the wheel, the tape is first divided into these equal units, and then the proper units are cut out to form a message. The units which are not cut out form the dots and dashes. To use a continuous tape it is necessary for its length to be some exact multiple of the unit, in order that it may start on the second revolution exactly as it did the first.

The generator current of high potential passed directly through the primary of a transformer, and the secondary was used as the source of electromotive force for the line. This secondary circuit which includes the line was brought to the transmitter to be operated upon as described.

A diagram of the electric circuits as employed in this experiment is shown in Fig. 8, where A represents the alternator, T the transformer, B the brush bearing upon the transmitting wheel, W, and L the line. Another diagram, illustrating how the method may be used with currents of the same or different frequencies, is given in Fig. 9, where several generators, A_1, A_2, A_3, etc., are represented upon the same shaft, and each is connected to a separate brush, B_1, B_2, B_3, etc., bearing upon the wheels, W_1, W_2, W_3, etc., upon a common shaft and connected to the line. By placing the insulating papers in the proper positions upon the wheels, it becomes possible to transmit in succession, first a current of one frequency and then of another, or of all at the same time.

FIG. 10.



11.

FIG. 12. Polarizing Receiver Record. Message sent at Fort Monroe, Va., Aug. 10, 1896, at the rate of about 1,200 words per minute. This particular message sent in one-half a second. The number of "dots" per second is 337. Continental Code is used.

If any error is made in laying off the units upon the tape, or if the length of the tape changes in any way after they are accurately laid off, the effect of this error is cumulative from period to period; and although at any particular time the tape might be in phase, sometime later it would not be so, and sparking would occur. This would also be the case if there were any slipping of the tape around the wheel, P. To overcome these difficulties it is only necessary to have holes punched at regular intervals in the tape which engage in pins at corresponding intervals on a wheel made to receive it.

A simple experimental method which does away with the necessity of making pins to feed the tape is to glue strips of thin paper, seen at C, Fig. 7, having lengths corresponding to the paper intervals of the tape, that is, one unit for a dot and two units for a dash, upon the circumference of the wheel, P, which has a smooth polished metal surface.

One brush is continually in contact with the wheel, and the other rides on to and off from these paper strips, making and breaking the circuit at the zero phase of the current. The length of message permitted is limited by the number of units in the circumference of the wheel, which in the example taken was 184.

Instead of using any gearing, as in the example given, to reduce the speed of revolution of the wheel, P, the tape might be run directly from a small wheel upon the armature shaft. The unit of this small wheel is one-tenth of its circumference, if there are ten poles to the generator, so that any message sent by fastening papers upon this wheel would be limited to ten semi-cycles. If a single unit of this small wheel is covered by paper, and the brush adjusted for no sparking, one semi-cycle in every ten will be omitted.

Records obtained by the use of paper fastened upon the large wheel, P, Fig. 7, are shown in Fig. 10, where it is seen that the word "telegraph" was transmitted. A record obtained by the use of tape is shown in Fig. 11, where the sentence "One wire will do work of ten" was transmitted on August 10, 1896. This message was sent at the rate of 337 semi-cycles of current per second, thus requiring about half a second altogether.

Since the speed of transmission depends upon the frequency of the alternating current, the limit of speed is determined by the particular alternator used. In the above example the alternator available was designed to run at a speed of about 1,600 revolutions of

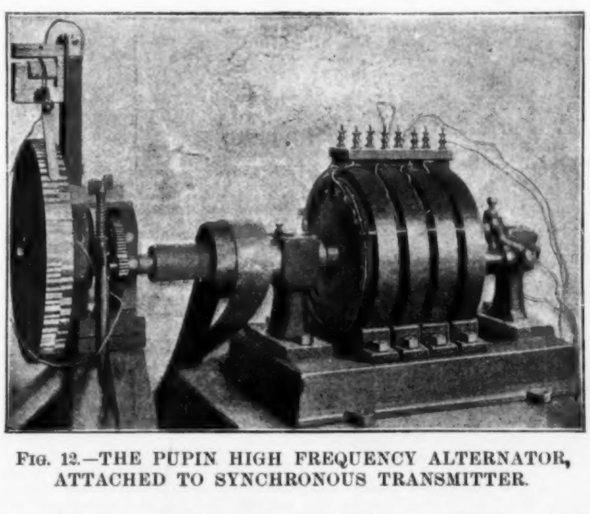


FIG. 12.—THE PUPIN HIGH FREQUENCY ALTERNATOR, ATTACHED TO SYNCHRONOUS TRANSMITTER.

the armature per minute, corresponding to a frequency of 133, or 266 alternations per second. To increase the speed of transmission, this alternator was run as high as 2,400 revolutions per minute, beyond which it was thought dangerous to go. This corresponds to a frequency of about 200 complete cycles or 400 alternations per second. Through the kindness of Dr. M. I. Pupin, of Columbia College, a special high frequency alternator was loaned for the purpose of testing this system at higher speeds of transmission. This alternator, shown in Fig. 12, is, in fact, four alternators upon the same shaft, having 18, 22, 26 and 30 poles respectively. To obtain the highest speed, the 30 pole machine was used, and the transmitting wheel geared to the shaft as with the 10 pole alternator. The speed of armature used was 2,180 revolutions per minute, corresponding to 1,090 semi-cycles per second, or 65,400 per minute, or a frequency of 545. No difficulty was experienced in sending and recording messages at this rapid rate, which corresponds to between three and four thousand words per minute.

(To be continued.)

PROGRESS OF ELECTRICAL ENGINEERING IN GERMANY.

FROM an interesting article in the Elektro-Techniker, by R. Lüders, it appears that in Germany within the last twelve months the supply of current to towns for lighting has increased about 20 per cent., as indicated by the number of lamps connected on to the central stations; a percentage increase which means about 150,000 lamps. The combination of lighting with electric traction seems to prove advantageous, and such installations have been pretty extensively carried out. The important reduction in price that follows from longer hours of consumption is illustrated by the tariff of an Upper Silesian installation, where the rate is 1·2 cents per hour up to 400 hours, and half a cent per hour thereafter. The driving of machine tools by the electric current has been considerably extended; the electric transmission of power on warships has also been very successful, says the Western Electrician.

In the field of railway working a considerable advance has to be noted; the electric current has been used for shifting points at Berlin-Westend and Untertrückheim stations. According to the reports of the principal firms, the alternate current, and especially polyphase, is fast gaining ground on the continuous current. The latter has been employed in an electric railway at Lugano.

At Dresden five street railway lines are driven with an expenditure of 1,500 horse power; the Hanover light railways consume 1,500 horse power developed in two power stations, and the extended Budapest street railway consumes 650 horse power. The total length of completed electric railways in Germany is 523 miles, while 512 miles are in course of construction.

On the first of October last year there were in Germany (excluding Bavaria and Wurtemberg) 8,554 heavy current installations at work, 8,160 of which were devoted to lighting purposes, and supplied 1,852,000 incandescent lamps and 79,000 arc lamps; 111 installations were used for electrolytic processes and 618 for power transmission.

In the telegraph engineer's department of the imperial post office several scientific investigations have been carried out; for instance, experiments on the spread of strong currents through the ground, and their availability for telegraphy without wires; investigations to determine the best form and material for telegraph lightning conductors and their earth connections, and investigations to discover the best means of protecting telephone, etc., lines from disturbances from leakage in heavy current circuits. In telegraphs and telephones a notable advance is to be seen; at the date cited the network of conductors in the German empire (including Bavaria and Wurtemberg) consisted of about 90,600 miles of line and 130,000 miles of conductor, against 87,500 miles of line and 98,500 miles conductor in the previous year. There are 21,271 telegraph offices, of which 8,591 are provided with telephones. Alarm signals can now be sent from 9,796 stations, whereas in the previous year the number of stations was only 8,441.

Special activity has been exhibited in the building of trunk lines for connecting the telephone installations of different towns. During last year 7,200 miles of conductor have been used for this purpose. There are at present in existence 484 city telephone exchanges and 125,810 telephones, for which on an average 1,720,000 connections are made per day. Berlin alone has 82,865 speaking places, for which the daily average number of connections is 450,000, a record which is as yet unsurpassed. The longest telephone line in Germany, between Berlin and Memel, is 600 miles in length.

The seeds or stones of many fruits which would apparently seem useless have some economic value, and in this connection we are speaking chiefly of those which are often thrown away. In certain parts of Egypt the date stones are boiled to soften them, and the camels and cattle are fed upon them. They are calcined by the Chinese, and enter into the composition of their Indian ink. In Spain they are burned and powdered for dentifrice, and vegetable ivory nuts are applied to the same purposes. Some species of Attalea nuts are burned in Brazil to blacken the raw caoutchouc or India rubber. The seed or stone of the tamarind is sometimes prescribed in India in cases of dysentery as a tonic, and in the form of an electuary. In times of scarcity the natives eat them after being roasted and soaked for a few hours in water; the dark outer skin comes off, and they are then boiled or fried. An oil has been obtained from this seed. The seed of the carob bean is ground up as food for cattle, and is used in Algeria, when roasted, as coffee.

The longest turntable in the world was completed recently at East Albany for the New York Central. It is intended not only for locomotives, but for sleeping and long private cars. It is 68½ feet in length, and its construction required 431 yards of concrete in the center of the table. As evidence of how nicely it is adjusted, a boy fourteen years of age turned one of the company's heaviest locomotives on it with but little effort, so perfect is its mechanical adjustment.

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